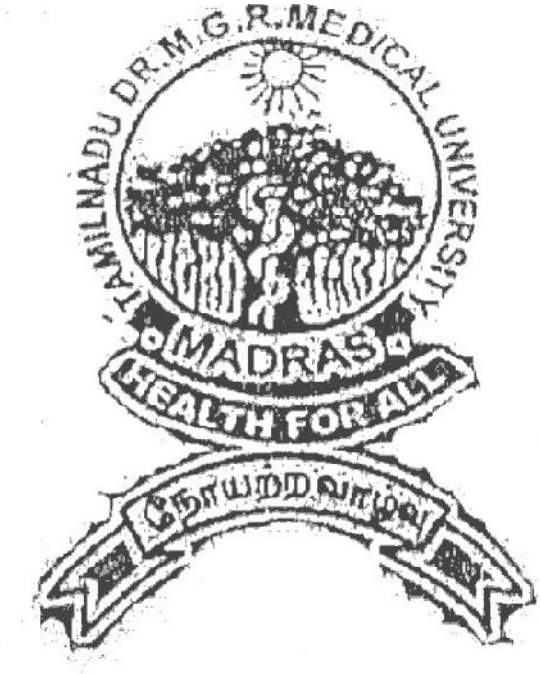
STUDY ON SERUM ZINC LEVELS IN ACUTE LOWER RESPIRATORY TRACT INFECTIONS IN CHILDREN AGED 6 MONTHS TO 5 YEARS



DISSERTATION SUBMITTED FOR

M.D.DEGREE EXAMINATION

BRANCH – VII PAEDIATRIC MEDICINE

KILPAUK MEDICAL COLLEGE

THE TAMILNADU DR.M.G.R.MEDICAL UNIVERSITY

APRIL 2013

CERTIFICATE

Certified that this dissertation entitled **"SERUM ZINC LEVELS IN ACUTE LOWER RESPIRATORY TRACT INFECTIONS"** is a bonafide work done by **DR J. JACINTH SHOBAH,** Post graduate student of Paediatric Medicine, Kilpauk Medical College and Hospital, Chennai – 10, during the academic year 2011 – 2013.

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DECLARATION

I declare that this dissertation entitled " **SERUM ZINC LEVELS IN ACUTE LOWER RESPIRATORY TRACT INFECTIONS IN CHILDREN AGED 6 MONTHS TO 5 YEARS "** has been conducted by me at the Department of Paediatrics in Government Royapettah Hospital attached to Kilpauk Medical College. It is submitted in partial fulfilment of the award of the degree of M.D. (Paediatrics) for the April 2013 examination to be held under the Tamil Nadu DR.M.G.R. Medical University, Chennai. I have not submitted this previously for the award of any degree or diploma from any other university. I express my sincere thanks to Prof. Dr. P. Ramakrishnan MD.,DLO., Dean, Kilpauk Medical College and Hospital, for allowing me to conduct this study using the available facilities.

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ABBREVIATIONS

ALRI	Acute lower respiratory tract infection
ARI	Acute respiratory tract infection
CD	Cluster of differentiation
CI	Confidence interval
DALY	Disability adjusted life year
DNA	Deoxyribonucleic acid
HDL	High density lipoprotein
Hib	Haemophilus influenza type b
Ig	Immunoglobulin
IGF-1	Insulin-like growth factor 1
LRI	Lower respiratory tract infection
MAC	Mid arm circumference
NK cell	Natural killer cell
PEM	Protein energy malnutrition
RNA	Ribonucleic acid
RSV	Respiratory syncytial virus
SD	Standard deviation
WHO	World health organization

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CERTIFICATE OF APPROVAL

The Institutional Ethical Committee of Govt. Kilpauk Medical College , Chennai reviewed and discussed the application for approval entitled "A Study of serum zinc levels in children (6 months to 5 years) with acute lower respiratory tract infections" submitted byDr.J.Jacinth Shobah, MD, (Paediatrics)PG Student Govt. Kilpauk Medical College Chennai.

The Proposal is APPROVED.

The Institutional Ethical Committee expects to be informed about the progress of the study any Adverse Drug Reaction Occurring in the Course of the study any change in the protocol and patient information /informed consent and asks to be provided a copy of the final report.

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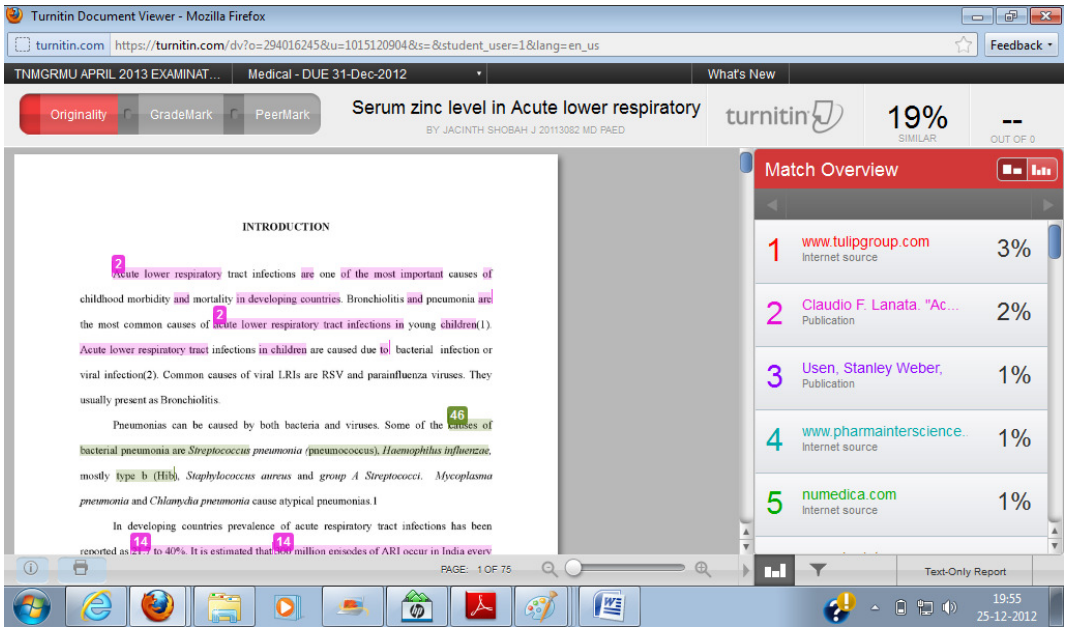
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Serum zinc level in Acute lower respiratory
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INTRODUCTION
Acute lower respiratory tract infections are one of the most important causes of childhood morbidity and mortality in developing countries. Bronchiolitis and pneumonia are the most common causes of acute lower respiratory tract infections in young children(1). Acute lower respiratory tract infections in children are caused due to bacterial infection or viral infection(2). Common causes of viral LRIs are RSV and parainfluenza viruses. They usually present as Bronchiolitis.
Pneumonias can be caused by both bacteria and viruses. Some of the causes of bacterial pneumonia are Streptococcus pneumonia (pneumococcus), Haemophilus influenzae, mostly type b (Hib), Staphylococcus aureus and group A Streptococci. Mycoplasma pneumonia and Chlamydia pneumonia cause atypical pneumonias.1
In developing countries prevalence of acute respiratory tract infections has been reported as 21 to 40%. It is estimated that 150 million episodes of ARI occur in India every
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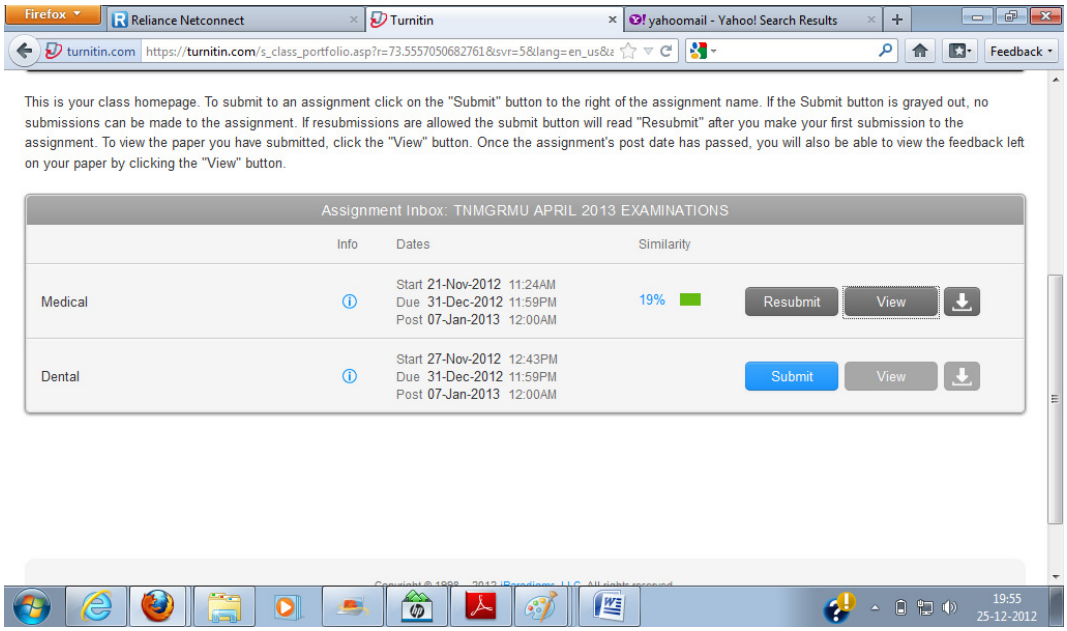
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INTRODUCTION

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In developing countries prevalence of acute respiratory tract infections has been reported as 21.7 to 40%. It is estimated that 300 million episodes of ARI occur in India every year; of these 30 to 60 millions are moderate to severe ARI. While every 6th child in the world is Indian, every 4th child who dies, comes from India(3).

In India, under-5 children constitute 13% of the total population and 25% to the mortality. Mortality statistics in India shows that ARIs cause 20%–35% of the mortality among under-5 children(4). The incidence of lower respiratory tract infection is 0.25–0.5 episodes /child/year(4). Various studies showed that among

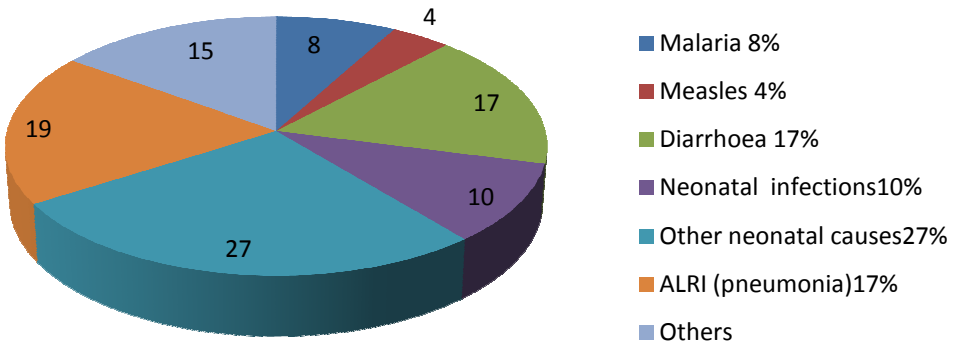
the ARI events in children, 87% to 90% are due to upper respiratory infections, and 10%–13% are due to acute lower respiratory tract infections.

Further, lower respiratory tract infections contribute 96.5% of mortality due to respiratory events. Studies showed that 33% of paediatric outpatients and admissions are due to acute respiratory events of which more than 90% admissions are due to lower respiratory tract infections(4).

According to WHO global distribution of cause - specific mortality in children less than 5 years in 2004 is as follows(5).

- Acute respiratory infections, mainly pneumonia (19%)
- Diarrhoeal diseases (17%)
- Other neonatal causes (27%)
- Neonatal infections such as sepsis (10%)
- Malaria (8%).
- Measles (4%)
- Others (15%)

Under five mortality causes



Preventive measures for respiratory illnesses:(1)

1. Avoidance of in utero and environmental tobacco smoke exposure
2. Prevention of low birth weight infants and prematurity
3. Promotion of breast feeding
4. Improvement in the living environment
5. Early treatment of respiratory infections
6. Promotion of improved nutrition
7. Timely immunizations particularly influenza vaccination
8. Improved parenting

Normal zinc status according to international reference values is defined as serum zinc levels between 60 µg/dl to 120µg/dl.(6)

Zinc is a catalytic metal ion present in the cytoplasm of cells of the body. Zinc is present in all cells, although about 80% is present in muscles and bone alone. It is present both in plasma and red cells of blood. One third of zinc in circulating plasma is bound to macroglobulin and to albumin.

Zinc is a key micronutrient required for intestinal mucosal integrity, skeletal growth and immune function predominantly cellular immunity and antioxidant activity. It is present in all organs, tissues and body fluids(7).

Seminal fluid has higher concentration of zinc. Zinc is a constituent of numerous enzymes such as carbonic anhydrase, carboxyl peptidase, alkaline phosphatase, DNA and RNA polymerase, reverse transcriptase and superoxide dismutase.

It has a lot of physiological functions. It is necessary for DNA replication and cell division. It has a role in maintaining cell integrity and immunity, and plays a key role in cells that have a rapid turnover. Therefore it plays a critical role in the control and prevention of infections.

Despite these functions, the body does not store zinc. There are no readily mobilizable stores of zinc like iron and requires a constant dietary intake. Sources of zinc are red meat, animal proteins, seafood, dairy products, cereals and nuts. Most vegetables are not good sources of zinc due to the presence of phytate that chelates zinc and prevents its absorption(7).

Although zinc's role in diarrhoea is known, zinc supplementation during diarrhoea is recommended based on several trials demonstrating the effect of zinc in reducing the duration, severity and recurrence of diarrhoea(8).

There are some studies showing zinc deficiency as a risk factor for acute lower respiratory tract infections and supplementation of zinc as a preventive measure in reducing the incidence of acute lower respiratory tract infections(9).

Trials with zinc supplementation in pneumonia (tachypnea plus one or more of retractions, bronchial breathing, crackles, nasal flaring, danger signs) showed

reduced incidence of acute lower respiratory tract infections. Trials have also shown that there is no therapeutic benefit of adding zinc to antibiotic therapy(10).

The balance of evidence suggests that(10)

1. Zinc supplementation for at least three months duration could be useful to prevent pneumonia defined by specific criteria.
2. Zinc does not have therapeutic value in childhood pneumonia.

REVIEW OF LITERATURE

Zinc is a trace mineral which means the body requires very small amounts (<100mg/day) to function properly(11). Other trace minerals include iron, manganese, copper, fluoride, molybdenum, iodine, chromium and selenium. Zinc is an important micronutrient present in all organs, tissues, body fluids and body secretions. After iron, zinc is the second most abundant trace element in the body.

The human body contains 2-3g of zinc(12). It ranges from 1.5g in women to 2.5g in men. Lean body mass concentration of zinc is 30µg/gram. It is distributed chiefly in skeletal muscles (60%) and bones (30%). High concentrations of zinc are found in the choroid of the eye (274µg/g) and in prostatic fluids (300-500mg/l).(13)

Other organs containing significant concentrations of zinc include liver, intestines, kidney, pancreas, lung, brain, heart and skin. Plasma zinc accounts for 0.1% of total body zinc, where it predominately exists in the bound form to several proteins like albumin, transferrin and α-macroglobulin.

Functions of zinc:

Zinc is essential for a wide variety of physiological functions. It is required for the metabolic activity of 300 of the body`s enzymes and is a component of metalloproteinase important for DNA replication and cell division, crucial for cellular immunity and antioxidant activity. These enzymes are involved with the

metabolism of carbohydrate, protein, fat and alcohol. Zinc is part of several enzyme systems such as carbonic anhydrase. Zinc influences cell division, DNA metabolism, RNA metabolism, growth, development, sexual maturation and normal functioning of the immune system. . Zinc is essential for the synthesis and action of insulin. Zinc plays a key role in protein and nucleic acid synthesis(14).

Zinc is required for the maintenance of normal skin and intestinal mucosal integrity, skeletal growth, sodium and water transport.

It is required for normal leukocyte function and cytokine expression(15). Zinc is also crucial to tissue growth, wound healing, prostaglandin production, bone mineralization, proper thyroid function, blood clotting, foetal growth and sperm production.

Zinc helps to enhance memory and improve mental functions and is especially critical for foetal brain development. Zinc is considered to play a key role in cells that have a rapid turnover and plays a crucial role in the control and prevention of infections.

Zinc deficiency is now recognized as an important health issue particularly in developing countries making it a part of the “top micronutrients to consider in interventions” list joining iron, vitamin A, folic acid and iodine.

Daily requirements:

Daily requirement of Zinc

Adult male	11 mg
Adult female	8 mg
Pregnancy and lactation	12 mg
Infants	2 mg
1 to 3 years	3 mg
4 to 8 years	5mg

The daily requirement of zinc for an adult male is 11mg, 8mg for women, 12mg for pregnant and lactating women, 2mg for infants, 3mg for children between 1-3years and 5mg for children between 4-8years(14).

Sources of zinc:

Zinc is more abundant in lean red meat, beef, lamb and pork. Seafood such as shellfish, whole wheat, nuts, legumes, whole grain cereals such as bran and germ and dairy products like cheese and eggs are also good sources of zinc. Vegetables are not a good source of zinc due to the presence of phytate that chelates zinc and prevents its absorption(13).

Zinc absorption and bioavailability:

The absorption of zinc in the gut probably occurs throughout the small intestine. Zinc absorption is highest in the jejunum. Several zinc transporters and binding proteins have been identified in the intestinal epithelial cells. The absorbed zinc is bound to albumin and then transported to the liver

Bioavailability of zinc:

People who depend on plant- based diets face the risk of zinc deficiency due to interference of phytate with zinc absorption. Phytate is present in plant foods such as fruits, leaves and vegetables and in whole grain cereals, legumes, nuts and seeds.

Phytate affects zinc absorption from the gastrointestinal tract through precipitation. As phytate cannot be digested or absorbed, zinc bound to phytate will pass through the intestines unabsorbed.

Milling of cereals removes bran which has high content of phytate. Fermentation of cereals hydrolyses phytate and results in more zinc becoming bioavailable. Increase in protein increases zinc absorption.

WHO categories diets into three categories based on the phytate/zinc molar ratio as(16)

1. Low zinc bio available with phytate/zinc molar ratio more than 15
2. Moderate zinc bio available with phytate/zinc molar ratio less than 10 and

3. High zinc bio available with phytate/zinc molar less than 5

Zinc absorption increases with the protein content of a meal. The absorption is higher from a diet rich in animal protein (beef, poultry, cheese, eggs) than from a diet rich in plant proteins (soy, legumes). Other protein sources such as milk protein (casein) have an inhibitory effect on zinc absorption.

Nutrient interactions with zinc:(11)

1. Copper: High zinc decreases copper absorption leading to leucopoenia, neutropenia and lowers HDL.
2. Iron: High zinc decreases iron absorption and vice versa, can lead to anaemia.
3. Calcium: Calcium along with phytic acid decreases zinc absorption.
4. Folic acid: Folate bioavailability may go up when zinc is present.
5. Protein: Protein deficiency can cause zinc deficiency.

Transport and storage of zinc:

Zinc is absorbed in the small intestine and binds to metallothionein, a storage protein. Metallothionein binds zinc to albumin and helps in transport to tissues, mostly muscle and bone. Excess zinc is sloughed off along with dead cells and excreted by the pancreas into the intestinal tract and leaves the body via the faeces and to a lesser extent in urine and sweat(11).

Zinc deficiency:

Severe zinc deficiency is defined as a condition characterized by short stature, hypogonadism, impaired immunity, skin diseases, cognitive dysfunction and anorexia(14). It is estimated that about one third of the world's population has zinc deficiency ranging from 4% to 73%. Although severe zinc deficiency is rare, mild to moderate zinc deficiency is quite common.

Symptoms of zinc deficiency:

Deficiency of zinc can lead to anorexia, loss of appetite, depression, loss of smell and taste sensation, hair loss, diminished wound healing and impaired immune system increasing the susceptibility to infections. In pregnant women, lack of zinc may lead to low birth weight babies and affect foetal brain development(11).

Deficiency of zinc in children will hinder their normal growth and development, and can lead to poor appetite, mental lethargy, short stature, diarrhoea, pneumonia and delayed sexual development.

Zinc deficient adult males may develop prostatic hyperplasia. Zinc deficiency can also lead to decreased sperm production and affect fertility(14).

Zinc deficiency can cause ocular problems such as myopia, cataracts, delayed dark adaptation and macular degeneration. Despite these important functions of zinc, it is not stored in the body. Therefore a constant dietary intake of zinc is essential.

Risk groups for Zinc deficiency:(19)

1. Rapid cell growth (Infants and children)
2. Insufficient intake
3. High phytate/ or fibre in food
4. Diarrhoea
5. Malabsorption
6. Parasitosis
7. Hot humid climate
8. Lactation
9. Genetic disease (acrodermatitis enteropathica, sickle cell anaemia)
10. Parenteral nutrition.

Mechanisms of zinc deficiency:

1. Inadequate intake
2. Increased requirement
3. Malabsorption
4. Increased losses
5. Impaired utilization

Acute lower respiratory tract infections:

Bronchiolitis and pneumonias including lobar pneumonia constitute majority of acute lower respiratory tract infections in children.

Bronchiolitis:

Acute Bronchiolitis is predominantly a viral disease. More than 50% are due to RSV. Other causes are para influenza, adenovirus and mycoplasma, human metavirus and human bocavirus. Bronchiolitis is more common in males, who have not been breast fed and who live in crowded places. Bronchiolitis is usually seen in less than 2 years(5).

Many factors like host, immunological and anatomical factors play a major role in the severity of the illness. Acute bronchiolitis is characterized by bronchiolar obstruction with edema, mucus and cellular debris. Hypoxemia is due to ventilation perfusion mismatch. Severe obstruction and respiratory fatigue can lead to hypercapnea. Bronchiolitis commonly presents with respiratory distress, tachypnea, wheeze or crepitations in infants and is usually preceded by upper respiratory illness.

Pneumonia:

Viral infections are a prominent cause of lower respiratory tract infections in children less than 5 years. Causes of pneumonia are RSV, other respiratory viruses, pneumococcus, H. Influenza, Mycoplasma pneumonia, group A streptococcus, etc.

The lower respiratory tract is normal sterile by physiological defence mechanism including mucociliary clearance, secretary IgA, macrophages and cough that clears the secretions. These immunological mechanisms prevent the pathogens invading the respiratory tract(5).

Children with pneumonia present with fever, cough, increased work of breathing (intercostal retractions, suprasternal retractions, nasal flaring) or tachypnea. In severe pneumonia child presents with grunting, central cyanosis, inability to feed, lethargy, unconsciousness or head nodding.

There is also evidence that the number of hospitalisations for acute lower respiratory tract infections is a risk factor for later respiratory morbidity and bronchiectasis. Therefore an intervention that reduces severity and frequency of acute lower respiratory tract infections would be useful(17).

There are many risk factors including demographic, socioeconomic, environmental and nutritional factors for development of acute lower respiratory tract infections.

Zinc deficiency has been shown as a risk factor for acute lower respiratory tract infections in recently available studies. In developing countries like India dietary zinc deficiency is widespread and is aggravated by acute and chronic infections.

Role of zinc in acute lower respiratory tract infections:

Zinc has an important role in the normal hosts defence mechanisms and immune system. Zinc deficiency damages epidermal cells and thus breaks the integrity of the physical barrier that prevents the entry of pathogens. Damage to gastrointestinal and respiratory tract occurs in zinc deficient state.

In severely zinc deficient children reduction in the size of thymus occurs thus affecting cell mediated immunity and T cell function. Mild zinc deficiency also depresses cell mediated immunity. It reduces serum thymulin and it is required for the biological actions of thymulin(18).

Zinc ions play an important role in T- lymphocyte generation, proliferation and function. Zinc deficiency results in lymphopenia and a reduction in T lymphocytes. There is decrease in the CD4+/CD8+ cells and reduced NK cell activity(18).

In zinc deficiency B lymphocyte development is also affected. Neutrophil chemotaxis and function are impaired in zinc deficiency. Monocytes and macrophage functions are also impaired.

Zinc also exhibits anti oxidant and ant inflammatory effects. Antibody production is also impaired in zinc deficiency. Worldwide zinc deficiency is responsible for 16 % of lower respiratory tract infections, 18% of malaria and 10% of diarrhoea.(20) The highest attributable fractions for lower respiratory tract infections occur in Southeast Asia.

Health benefits of zinc:

1. **Immune system:**

Zinc is a component of thymic hormone which facilitates the maturation of lymphocytes. Due to zinc`s role in maintaining skin and mucus membranes, it is important for wound healing. Zinc prevents the replication of rhinovirus which is responsible for common cold.

2. **Growth and development:**

Zinc affects the growth regulating hormone IGF-1. In zinc deficiency this hormone cannot function properly leading to stunted growth in young children.

3. **Pregnancy:**

Zinc deficiency can lead to in utero growth retardation, two-fold increase in risk of low birth weight and higher risk of pre-term delivery.

4. **Reproductive health:**

Zinc is required for the normal function of prostate gland, to manufacture testosterone, and to ensure healthy sperm production since the pituitary glands need zinc to release hormones to produce testosterone(14).

Zinc also inhibits the aromatase enzyme that converts testosterone into excess estrogen. The testosterone to estrogen ratio declines with age from a high of 50:1 to half or even as low as 10:1. Higher estrogen activity results in increased risk of heart disease and obesity.

Zinc deficiency predisposes the prostate gland to infection (prostatitis) and enlargement (prostatic hypertrophy).

5. Glycemic control:

Decrease in zinc decreases the insulin response thereby destabilizing the blood sugar. Zinc deficiency also decreases the metabolic rate.

6. Thyroid:

In zinc deficiency iodine cannot assist the thyroid gland to produce thyroid hormone thereby leading to decreased hormonal output.

7. Taste and smell:

Gustin a protein responsible for taste found in saliva needs zinc for normal function. Since smell and taste are interconnected, zinc deficiency causes impaired taste and smell.

8. Eye:

Zinc is needed to convert retinol to retinal allowing for proper night vision. Zinc prevents cellular damage to retina and macula. Zinc in the retina decreases with age and zinc deficiency predisposes to age related macular degeneration(11).

9. Brain:

Zinc is found in the mossy fiber system of hippocampus. These fibres play a role in enhancing memory and thinking skills.

10. Skin:

Zinc is essential for healthy skin. Zinc stimulates cell division, normal skin healing, proper connective tissue formation and transport of vitamin A from liver to skin. Zinc compounds are used in the treatment of nappy rash, acne and sunburn.

Zinc toxicity:

Excessive exposure to zinc can occur by inhalation, through skin or by ingestion. Zinc toxicity can cause lethargy, focal neuronal deficits, metal fume fever, nausea, vomiting, epigastric pain, diarrhoea, increased risk of prostate cancer, copper deficiency and altered lymphocyte function.

ZINC IN ACUTE LOWER RESPIRATORY INFECTIONS:

Infant and child zinc supplementation has been extensively studied because dietary zinc deficiency is highly prevalent in developing countries. Indian children are particularly vulnerable to zinc deficiency because of inadequate breast feeding, improper weaning foods, cereal-based diet and frequent diarrhoeal illness.

A recent meta- analysis of randomized efficacy trials conducted in south Asia has confirmed that routine oral daily or weekly supplementation of zinc for at least three months

significantly reduces the incidence of childhood acute lower respiratory tract infections(19).

Further this effect of zinc has been found to be more specific for non-wheezy acute lower respiratory tract infections which is more likely to be due to pneumonia than viral bronchiolitis. This effect appears to increase with greater severity of disease and was not evident in infants less than six months of age.

In contrast to the prophylactic effect of zinc, there is no strong evidence of any benefit of zinc supplementation in the treatment of acute lower respiratory tract infections.

Studies on zinc in acute lower respiratory tract infections:

A study done in well nourished children in Bangladesh (Shakur M S et al 2004) showed that serum zinc was low in children suffering from acute lower respiratory tract infections as compared to controls(90µg/dL versus 176µg/dL). (21)

In another study of the serum and hair zinc status done in Bangladesh (Shakur M S et al 2009) in children with protein energy malnutrition(PEM) associated with or without acute lower respiratory tract infections, both serum and hair zinc were found significantly low in PEM associated with acute lower respiratory tract infections(22).

Arica S et al(2011) studied serum zinc levels in children younger than 2 years diagnosed with pneumonia. Zinc and iron values in the control group were significantly higher compared to the patient group. Mean total protein was also significantly higher in control group compared to patient group(23).

A study regarding the association of serum zinc level with severe pneumonia in children of 2- 60 months age done by Pushpa et al(2009) showed mean serum zinc level was 184µg/dl in the study group compared to 206µg/dl in the control group which was statistically significant(24).

Wahed M A et al(2008) studied the effects of supplementation of 5 micronutrients(vitamin A,C,E, folic acid and zinc) in under-5 children on the morbidity and duration of hospital stay in pneumonia. The average level of all the micronutrients were low in the study group compared to the control group. The average duration of hospital stay was 6.75days in study group versus 7.75days in control group(25).

Javed F et al(2009) compared serum zinc levels between healthy and malnourished children. The mean serum zinc level of healthy children was 99.97µg/dl compared to 51.2µg/dl in malnourished children(26).

Coles C L et al(2008) evaluated the effect of zinc prophylaxis on the association between nasopharyngeal colonization of streptococcus pneumonia and acute lower respiratory tract infections in children aged 1-35 months in Nepal.(27) Streptococcus pneumonia carriage increased the risk of acute lower respiratory tract infections in the control group but not in the zinc study group. The odds of acute lower respiratory tract infections for streptococcus carriers was 30 times greater than in the zinc group.

According to Kumar et al children with severe pneumonia have lower blood zinc levels than age, sex and nutritional status matched controls. (28)

Brooks et al studied effect of zinc on children less than 2 years old with pneumonia. Children with pneumonia were divided into 2 groups. 20 mg of elemental zinc given to case group and control group received placebo. In children who received zinc there was improvement in the severity of disease. Duration of hospital stay was shorter in children receiving zinc.(29)

According to Mahalanabis et al severity of disease was decreased in those patients who received zinc. (30)

AIM OF THE STUDY

The aim of this study is to

- Assess the serum level of zinc in acute lower respiratory tract infections
- Correlate with the need for intravenous antibiotics, severity and recovery pattern of acute lower respiratory tract infections
- Compare with age , sex and nutritional status matched controls

MATERIALS AND METHODS

STUDY DESIGN :

This is a case control study conducted in the Paediatric Department of Government Royapettah Hospital attached to Kilpauk Medical college during the period between March 2012 to September 2012.

SAMPLE SIZE :

The study population was chosen from the children coming to the paediatric department of Government Royapettah Hospital. The sample size included 100 cases of Acute lower respiratory tract infection and 100 sex, age and nutritional status matched children as controls

INCLUSION CRITERIA :

Children aged 6 months to 5 years admitted in the Paediatric Department of Government Royapettah hospital with cough with fast breathing and fever were included in the study

A diagnosis of severe acute lower respiratory tract infection was based on the presence of tachypnea, chest retractions and signs of severe disease such as high fever, convulsions, extreme lethargy or inability to suck or drink.

Moderate cases were defined as those with tachypnnea and chest retractions.

Children presenting with only tachypnnea were diagnosed to have mild acute lower respiratory tract infections.

Severity of ALRIs

Mild ALRI	Tachypnea
Moderate ALRI	Tachypnea with chest retractions
Severe ALRI	Tachypnea with chest retractions and High fever, convulsions, extreme lethargy or inability to suck or drink

To label the child as tachypneic, the WHO guidelines were followed. For children less than 2 months, respiratory rate 60 and above per minute, for 2 to 12 months, respiratory rate of 50 and per minute and more than 1 year respiratory rate of 40 and above per minute was labelled as tachypnea. The respiratory rate was counted for one minute

100 children age, sex and nutritional status matched with 100 cases of ALRI wre taken as controls. Normal siblings or children accompanying sick children or children coming for immunization were taken as controls.

EXCLUSION CRITERIA :

Children with a clinical diagnosis of childhoodl asthma based on wheeze, history of repeated similar episodes, positive family history of bronchial asthma and rapid response to bronchodilator therapy were excluded from the study.

Children with diarrhoeal episodes within the last three months were also excluded in the study.

Children already on zinc supplementation were also excluded.

Children satisfying the inclusion criteria were enrolled in the study. The details of study procedure was explained and an informed consent from the parents/ Guardian was obtained. The study was reviewed and approved by the ethical committee

Complete physical examination including anthropometry to assess the nutritional status was done for all children included in the study (cases and controls).

Anthropometry is a simple tool and is the gold standard to assess nutritional status.

Weight:

Weight is an important parameter in assessing the nutritional status of a child.

The weight of the child was measured with shoes removed and minimal clothing. The child was not in touch with any other object. The measured weight was corrected to the nearest value of plus 100 gms.

Height /Length :

Height of a child was measured in standing posture. Length of the child was measured in children less than 2 years in lying posture. The difference between height and length is 2cm.

For children less than 2 years length was measured using an infantometer. Length measurement required two people. The child's shoes were removed &

child was placed on a flat surface. One person fixed the top of child's head against the fixed vertical board with the eyes of child eyes looking upwards.

The second person pressed the knees together and down firmly in such a way that they touched the horizontal surface. The mobile foot board was moved till it touches the heels with the feet kept at right angle. The height was measured and corrected up to the nearest 0.5cm.

For children more than two years, the height was measured using a stadiometer. Stadiometer consists of a fixed vertical board and a mobile head piece. The child was made to stand bare foot with shoes and socks removed and with both feet and knees together. The child was made to stand in such a way that the heels, buttocks, shoulders and occiput touched the vertical board .

The head should be kept straight in Frankfurt plane that is the line joining the lower margin of the orbit and the upper margin of the external auditory canal should be in a straight line.

The height was measured by lowering the mobile head piece and placing it horizontally so that it touched the top of head. The height was measured up to the nearest 0.5cm for accuracy

Mid arm circumference:

The mid arm circumference was measured using a non stretchable tape with the arm hanging by the side of the body. It was measured mid way between the acromion and the olecranon process with the tape fitting snugly around the arm and not compressing the skin. The measurement was taken to the nearest 0.1 cm.

At the time of enrolment a baseline assessment including a detailed physical examination was performed. Chest X-Ray was taken for all cases of acute lower respiratory tract infections.

At the time of admission 3 ml of venous blood was collected by venipuncture in zinc free test tubes. The blood samples were then transported to lab where serum zinc concentration was measured using colorimetric method.

METHOD OF SAMPLE COLLECTION:

Blood sample of 3 ml was collected by venipuncture in zinc free test tubes. The serum was then carefully separated by centrifuging the collected blood sample. Care was taken so that the sample was not lysed as 75-85% of zinc are in erythrocytes, 12-22% in plasma, and 3% in leukocytes in blood. Therefore the amount of zinc measured in serum will be artifactually high if hemolysis occurs. If hemolysis occurred, then another sample of blood was collected from the same child.

ESTIMATION OF SERUM ZINC USING COLORIMETRIC METHOD(31)

PRINCIPLE:

Zinc in an alkaline medium reacts with Nitro-PAPS to form a purple coloured complex. Intensity of the complex formed is directly proportional to the amount of zinc present in the sample.

Alkaline Medium

Zinc + Nitro-PAPS ----------> Purple Coloured Complex

The increase of absorbance is measured and it is proportional to the concentration of total zinc in the sample.

NORMAL REFERENCE VALUES(6)

Serum : 60-120 µg/dl

It is recommended that each laboratory establish its own normal range representing its patient population.

CONTENTS	25 ml	75 ml
L1 : Buffer Reagent	20 ml	60 ml
L2 : Color Reagent	5 ml	15 ml
S: Zinc Standard (200 mg/dl)	2 ml	2 ml

STORAGE / STABILITY

Contents are stable at 2-8°C till the expiry mentioned on the labels.

REAGENT PREPARATION

Reagents are ready to use.

Working reagent:

Pour the contents of 1 bottle of L2 (Enzyme Reagent 2) into 1 bottle of L1 (Enzyme Reagent (1). This working reagent is stable for at least 2 weeks when stored at 2-8°C.

Alternatively for flexibility as much of working reagent may be made as and when desired by mixing together 4 parts of L1 (Enzyme Reagent 1) and 1 part of L2 (Enzyme Reagent (2).

Alternatively 0.8 ml of L1 and 0.2 ml of L2 may also be used instead of 1 ml of the working reagent directly during the assay.

SAMPLE MATERIAL

Serum (Free from haemolysis)

Zinc is reported to be stable in serum for 7 days at 2-8°C.

PROCEDURE

Wavelength/filter	: 570 nm (Hg 578 nm) / Yellow
Temperature	: R.T.
Light path	: 1 cm

Pipette into clean dry test tubes labelled as Blank (B), Standard (S) and Test (T):

Addition Sequence	**B (ml)**	**S (ml)**	**T (ml)**
Working Reagent	1.0	1.0	1.0
Distilled Water	0.05	--	--
Zinc Standard (S)	--	0.05	--
Sample	--	--	0.05

Mix well and incubate at R.T. (25°C) for 5 minutes.

Measure the absorbance of the sample **As** and the absorbance of standard **Ast** against reagent blank within 20 minutes.

CALCULATION:

Zinc concentration in the sample was calculated with the following formula.

$$\textit{Zinc concentration(mg/dl)} = \frac{\textit{Aspecimen}}{\textit{Astandard}} \textit{ X 200}$$

All the data were collected and written on a predesigned proforma. The variables analyzed were as follows age, sex , nutritional status which included weight for age%, weight for height% and mid arm circumference, disease pattern,

severity, need of antibiotics, need of O_2, SpO2, duration of hospital stay and serum zinc status. For all children who had zinc deficiency zinc was supplemented 20 mg daily for 14 days.

The data were entered in excel and statistical analysis was done using SPSS 11.5 version statistical software.

Descriptive analysis was used. Means with standard deviations were calculated. P-values were obtained by applying ANOVA and Chisquare test to analyze the data.

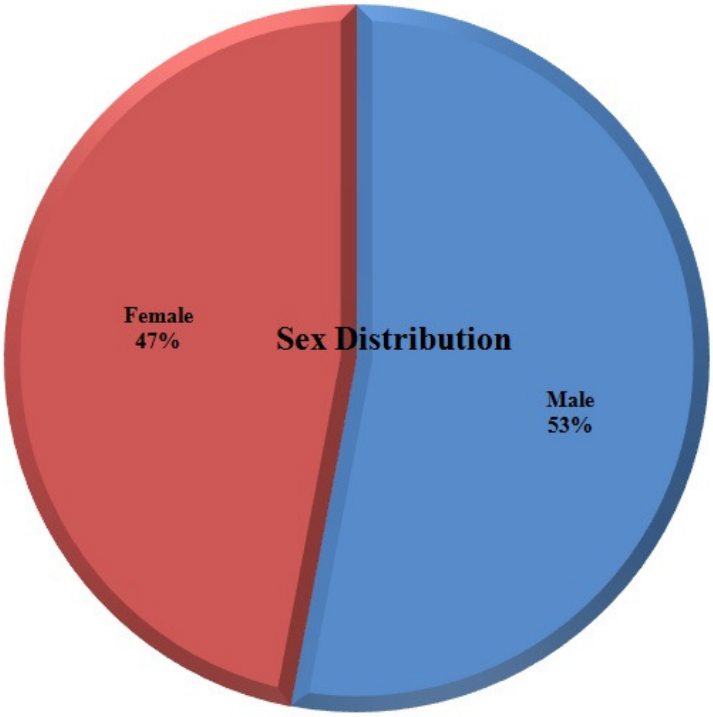
DESCRIPTIVE STATISTICS

100 cases of acute lower respiratory tract infections were studied and 100 controls matched with age sex and nutritional status were taken into the study. Age was matched with in 3 months and for matching nutritional status weight for age was taken.

As children were age and sex matched in both cases and controls, the number of children in each age group and the number of males and females in cases and controls were the same.

There were 53 (53%) males and 47 (47 %) females in each group. The mean age group in male and in female was 2 years.

Sex distribution of cases and controls

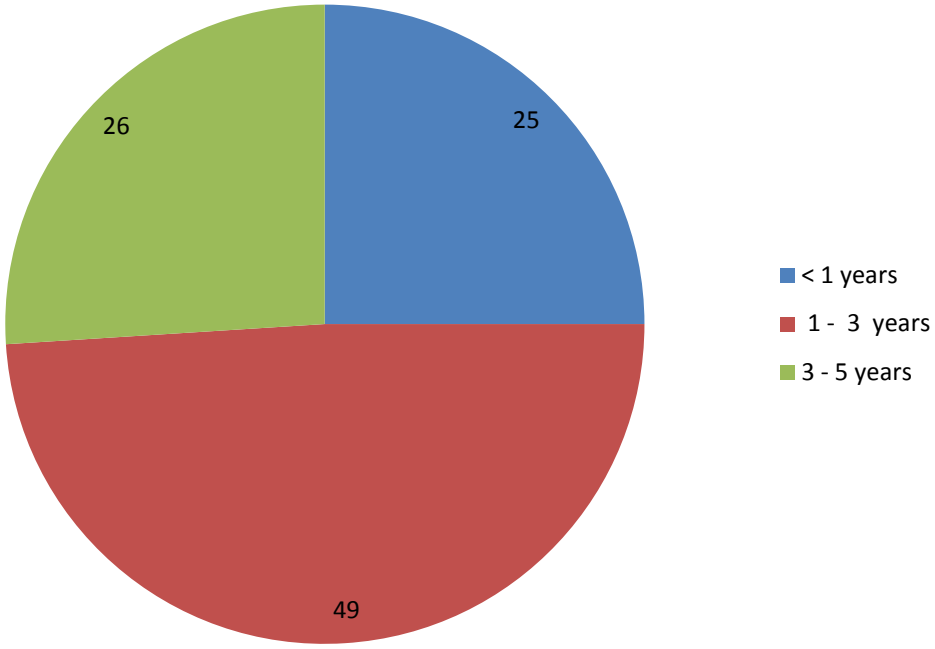


DISTRIBUTION ACCORDING TO AGE :

There were 25 children in the age group less than 1 year , 49 children in 1 to 3 years age group and 26 children in the age group of 3 to 5 years.

The mean of age group of less than 1 year, 1 to 3 years and 3 to 5 years in cases were 9 months, 2 years and 3.75 years respectively.

The mean of age group of less than 1 year , 1 to 3 years and 3 to 5 years in controls were 9.5, 2.25 years and 3.75 years respectively.



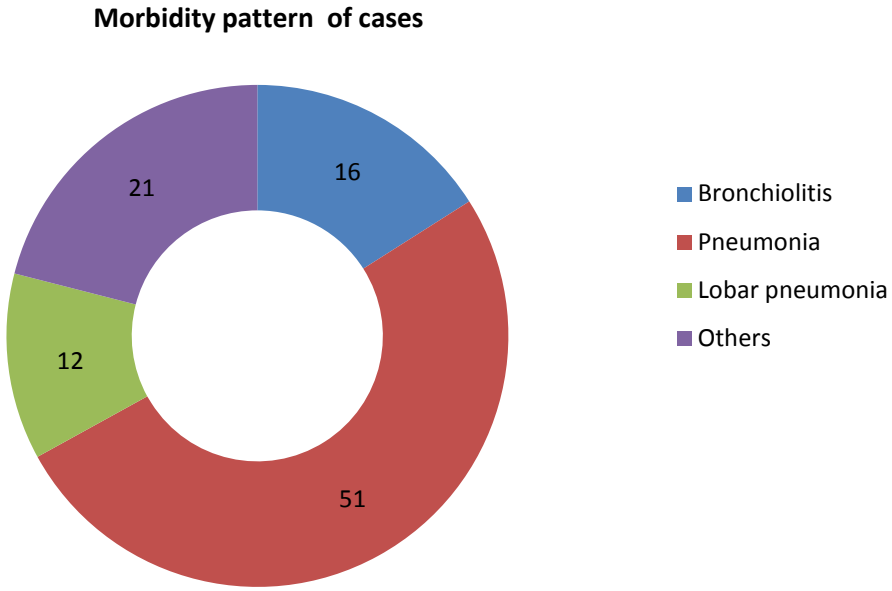
Age distribution in cases and controls

MORBIDITY PATTERN :

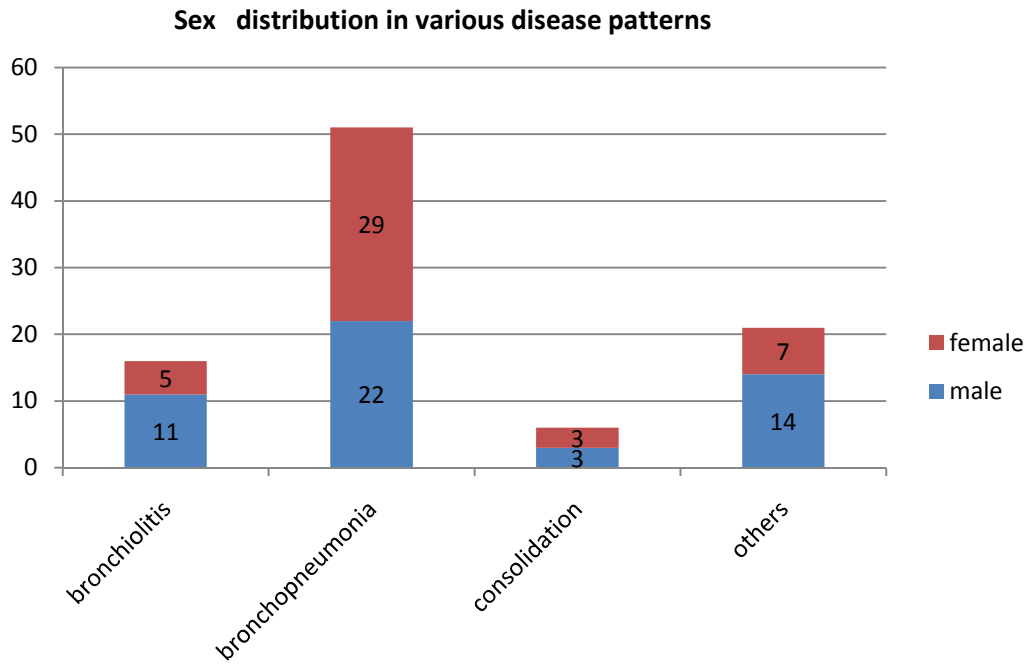
Among the 100 cases of acute lower respiratory tract infections there were 16 cases of bronchiolitis , 51 cases of pneumonia, 12 cases of lobar pneumonia and 21 cases with clinical diagnosis of acute lower respiratory tract infections and no radiological abnormality. In this study the majority of the cases were pneumonia.

The mean age of bronchiolitis, pneumonia and lobar pneumonia were 1 year, 2 ½

years and 1 ¾ years respectively.

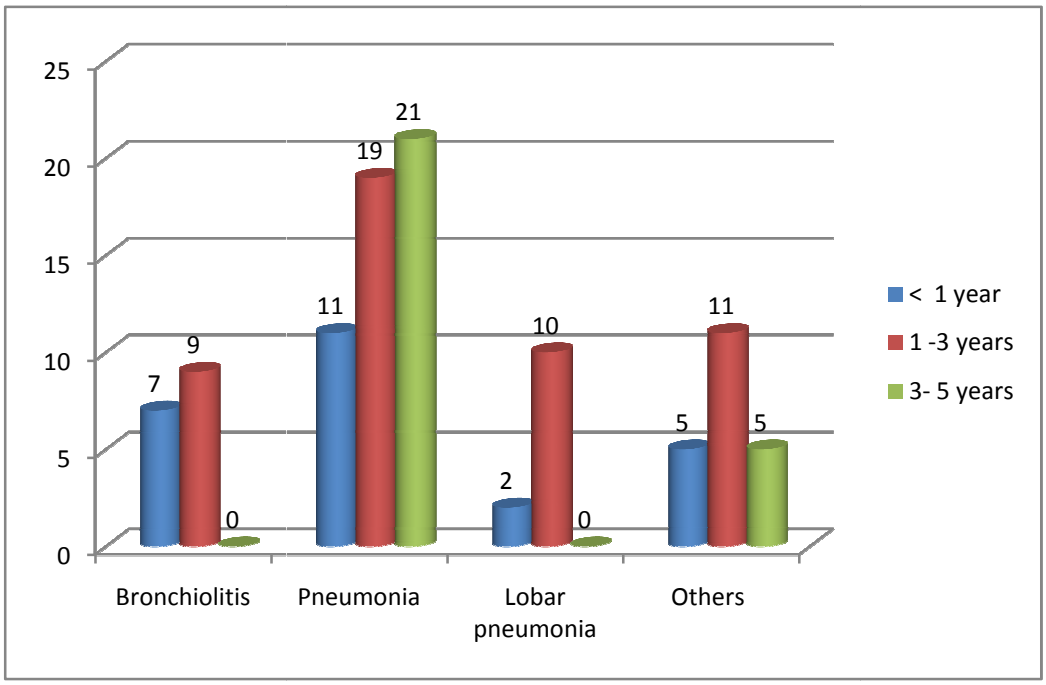


In bronchiolitis there were 11 males and 5 females. In pneumonia there were 22 males and 29 females. In lobar pneumonia there were 6 males and 6 females .



The mean age in bronchiolitis, pneumonia, lobar pneumonia and cases with clinical diagnosis of acute lower respiratory tract infections and no radiological abnormality were 1 year , 2 ½ years , 1 ¾ years and 2 ¼ years respectively. Bronchiolitis was seen more in the age group of less than 1 year. Lobar pneumonia was seen in more in the age group of 1 to 3 years and pneumonia seen more in the age group of 3 to 5 years.

Age distribution in various disease patterns



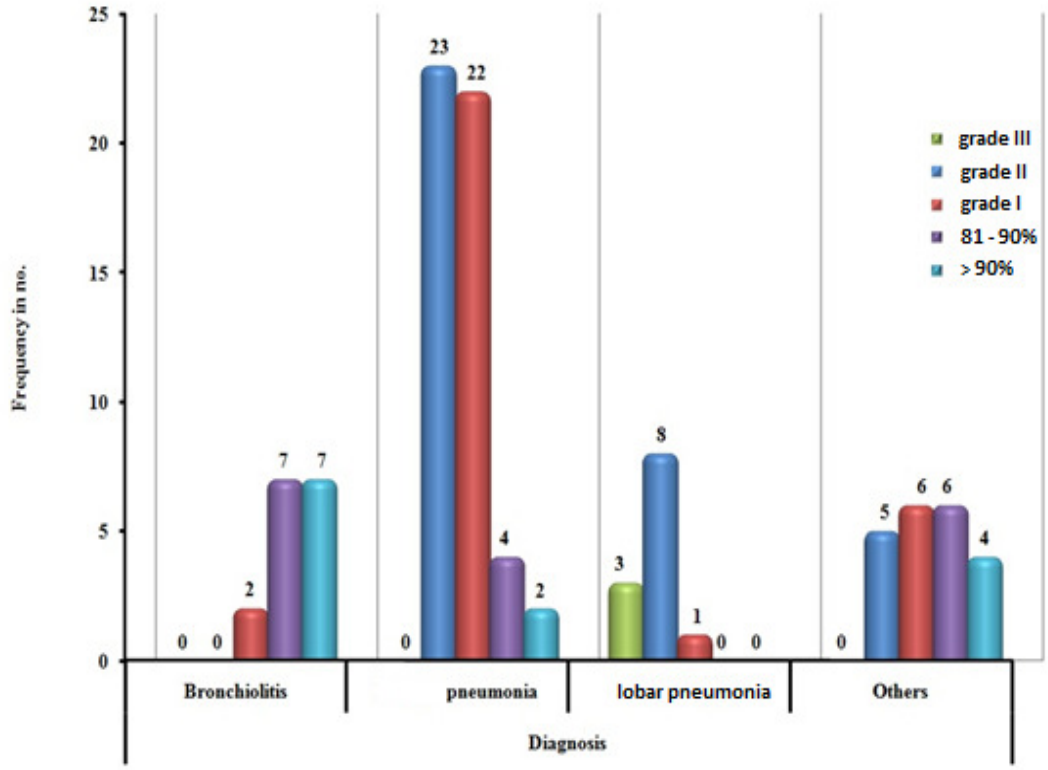
IAP classification (weight for age %)

Normal	> 80%
Grade I PEM	71 to 80%
Grade II PEM	61 to 70%
Grade III PEM	51 to 60 %
Grade IV PEM	< 50%

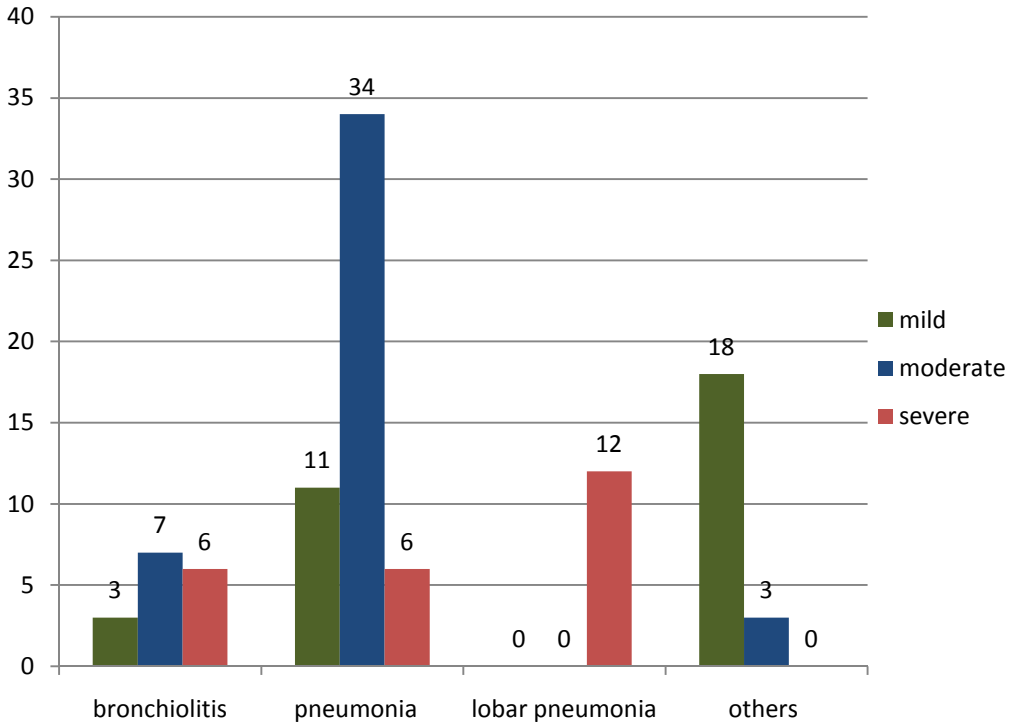
The distribution of cases according to nutritional status in the various disease patterns is shown on the following chart. The nutritional status or malnutrition was graded based on the IAP classification (weight for age (%) of the 50th percentile is calculated).

According to the study, nutritional status in bronchiolitis was normal. Lobar pneumonia was seen more in grade II and grade III malnutrition. In pneumonia the nutritional status of the children in this study was mostly normal or grade I PEM.

Distribution according to Nutritional Status in various disease patterns



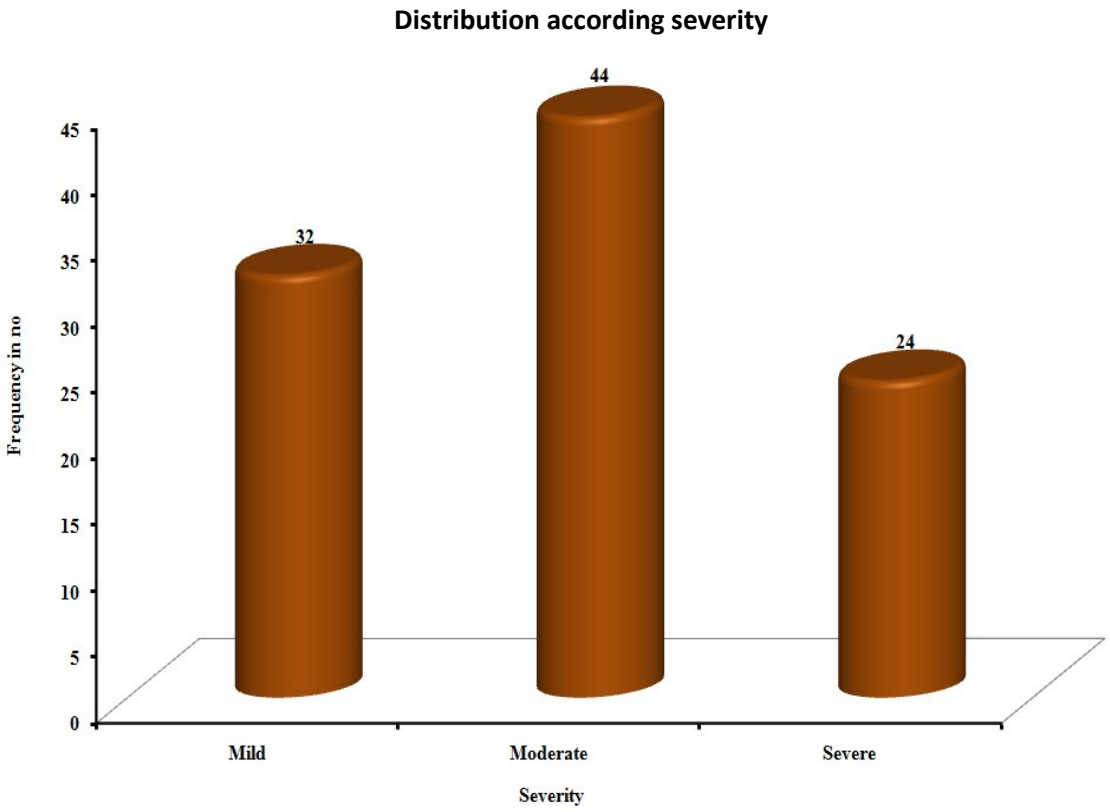
Severity in various disease patterns



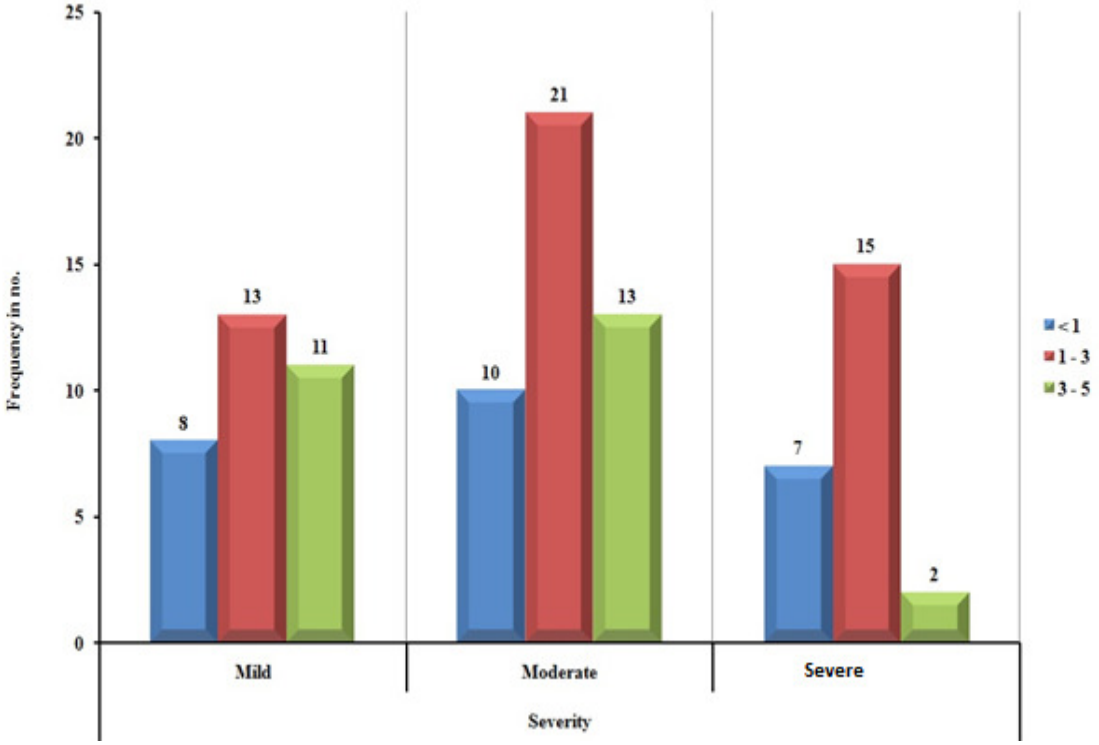
The distribution of cases according to the severity in the various disease pattern in acute lower respiratory tract infections is shown in the above bar diagram.

In this study most cases of bronchiolitis and pneumonia presented as moderate acute lower respiratory tract infections while in lobar pneumonia the presentation was mostly severe.

DISTRIBUTION OF CASES ACCORDING TO THE SEVERITY



The above bar diagram shows the distribution of cases according to the severity of illness. In our hospital most cases presented as moderate and mild acute lower respiratory tract infections. However the difference of presentation for mild and moderate was not statistically significant.

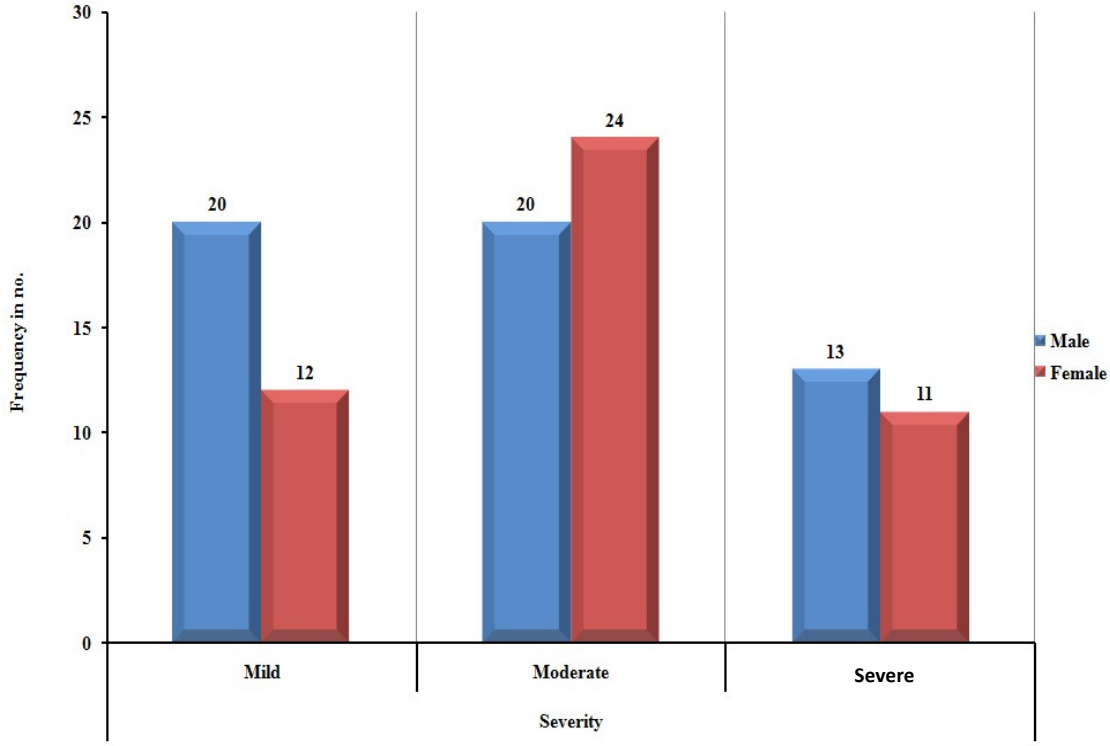


Distribution according to age and severity

The distribution of cases according to age group and severity is shown in the above bar diagram. In this study more number of severe cases were seen in the age group of 1 to 3 years that is the toddlers. There was not much of significant difference in the severity in infants and the preschool age group that is 3 to 5 years who presented mostly as moderate and mild acute lower respiratory tract infections. The mean age in mild, moderate and severe ALRI was 2 ½ , 2 and 1 ½ years respectively.

The distribution of cases according to sex in mild, moderate and severe acute lower respiratory tract infections is shown in the following bar diagram.

There was no significant statistical difference in male or female predominance in the severity of acute lower respiratory tract infections.



Distribution according to sex and severity

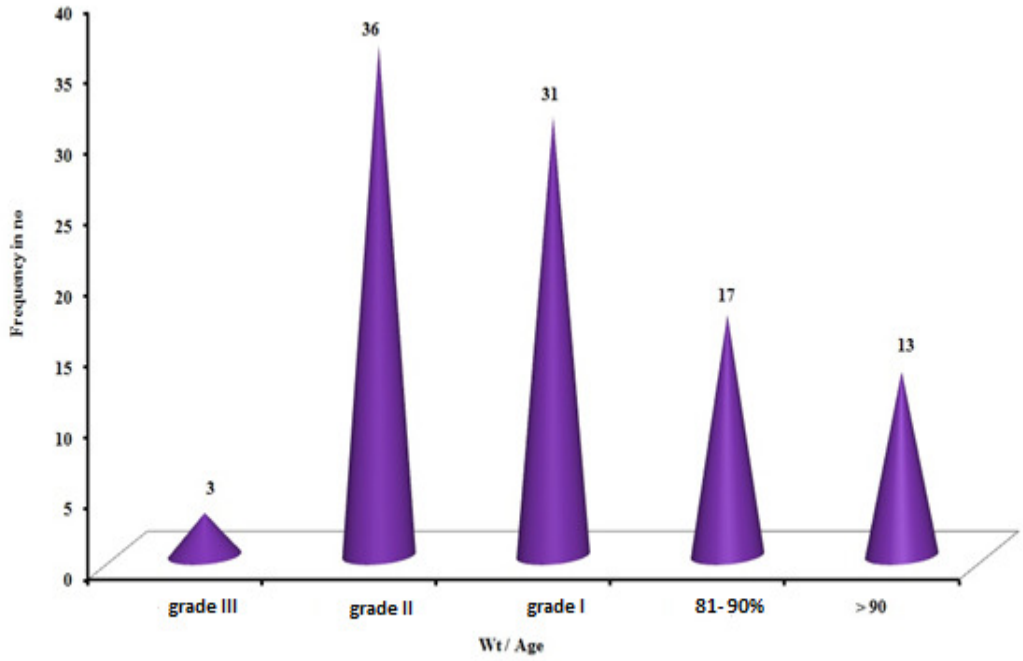
ACCORDING TO NUTRITIONAL STATUS

The nutritional status in the study population was assessed by the measuring the anthropometry and grading the nutritional status by

IAP classification - weight for age %

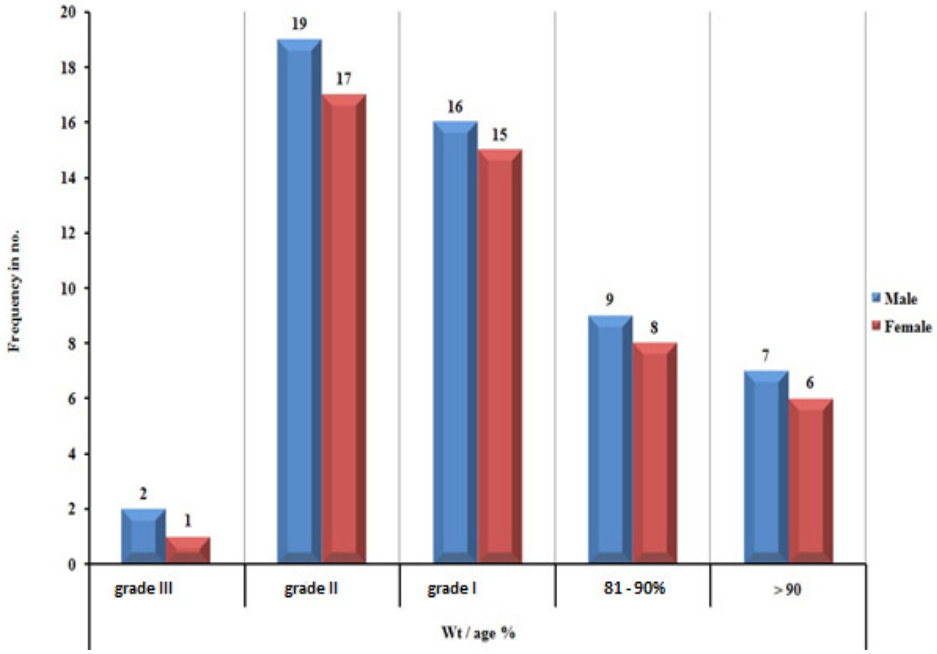
Waterlows classification – weight for height % and

Mid arm circumference



Nutritional status – IAP classification in cases and controls

The above bar diagram shows the nutritional status of the study population. Most of the children fall under grade II PEM followed by grade I PEM.

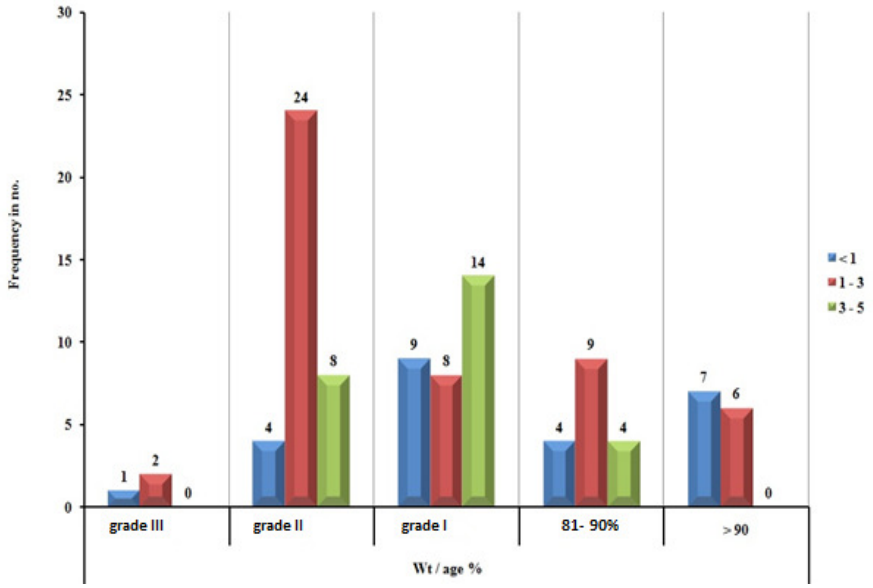


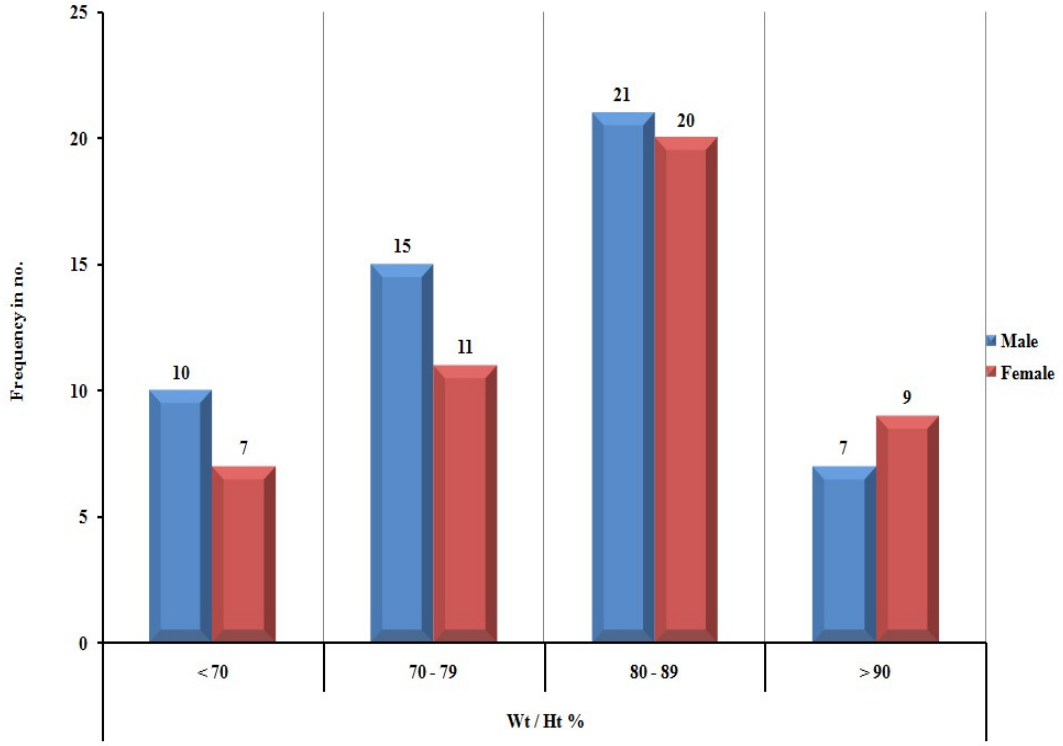
Sex Distribution in weight for age%

The male female distribution according to the IAP classification was almost equal.

The following bar diagram shows the nutritional status in various age groups that is infants, toddlers and preschool children. In this study most of them had grade II PEM and majority of them were toddlers.

Distribution according to age and nutritional status



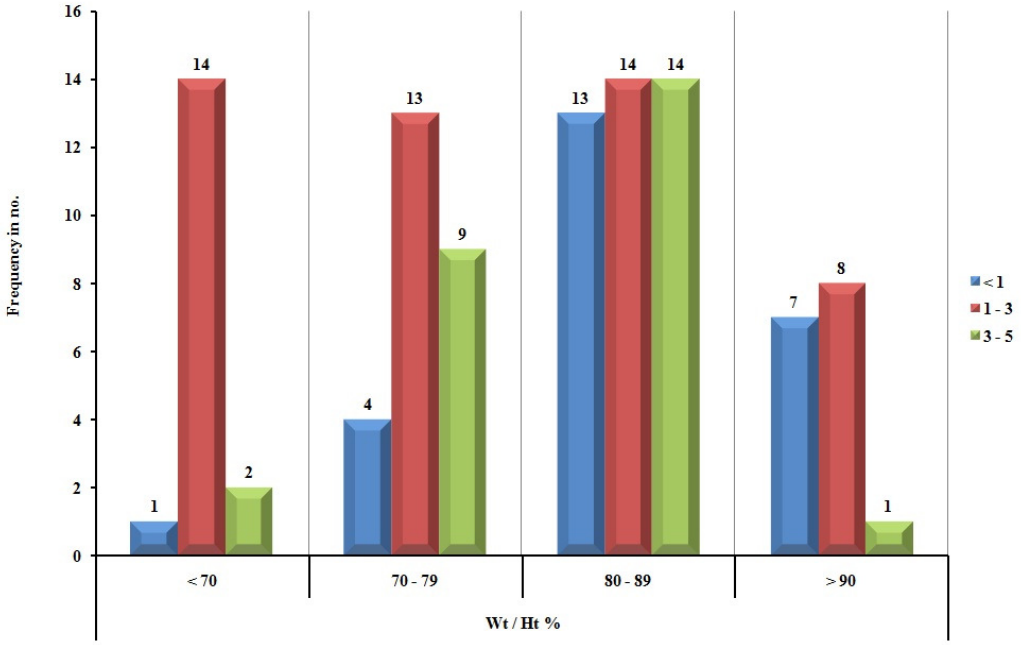


Weight for height% and sex distribution

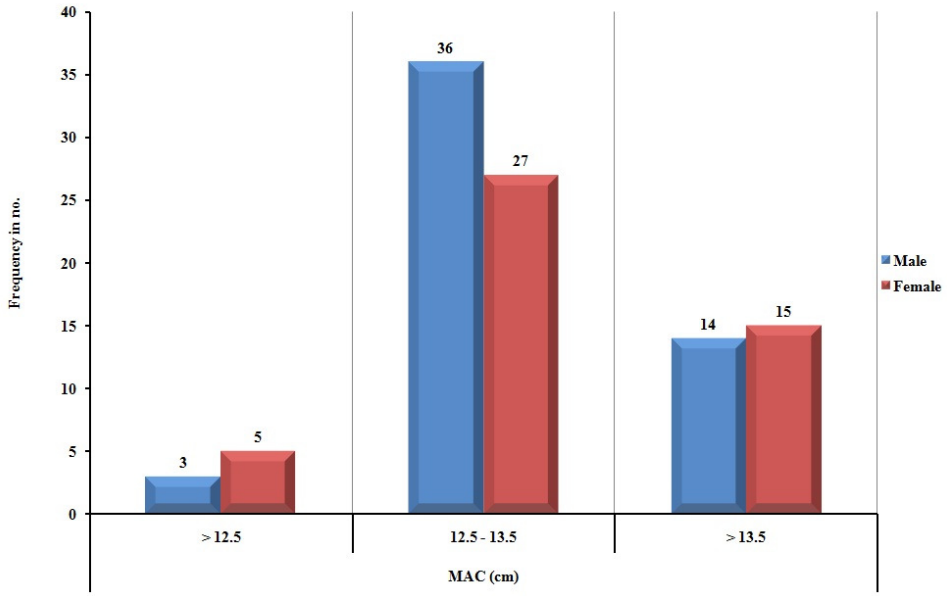
Waterlows classification is based on weight for height%. There was no significant difference in the male female distribution according to the Waterlows classification.

Normal	>90%
Mild wasting	80 to 90%
Moderate wasting	70-79%
Severe wasting	< 70%

Age distribution in weight for height %



In our study population most of the children in the age group 1 to 3 years had severe and moderate wasting.

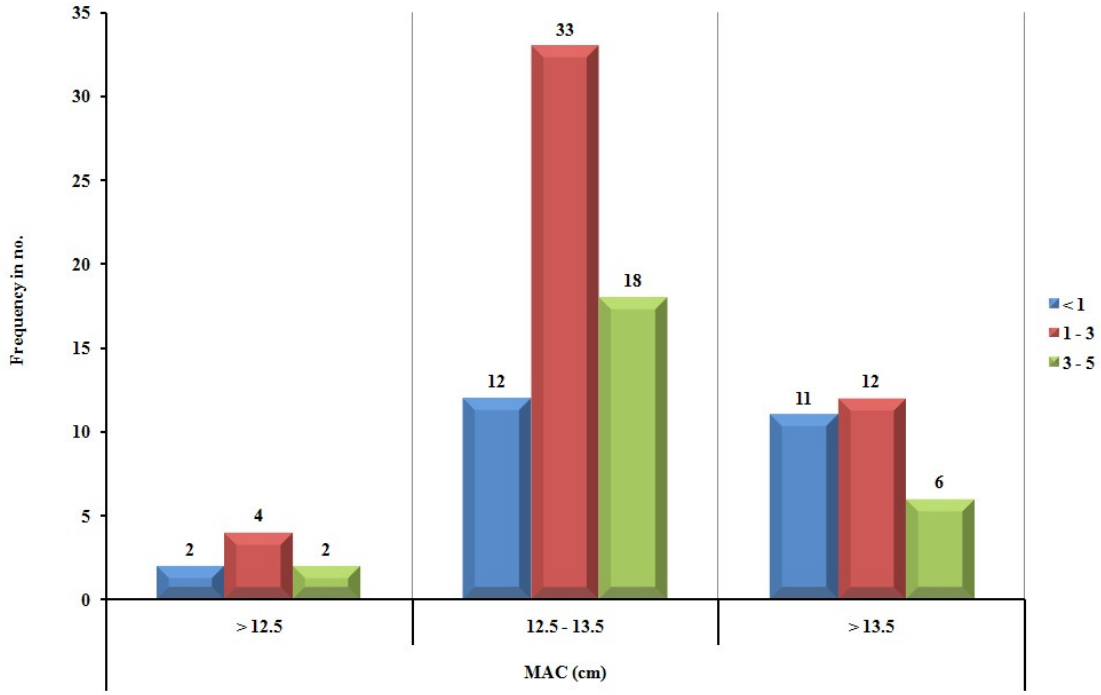


Male- female distribution and MAC

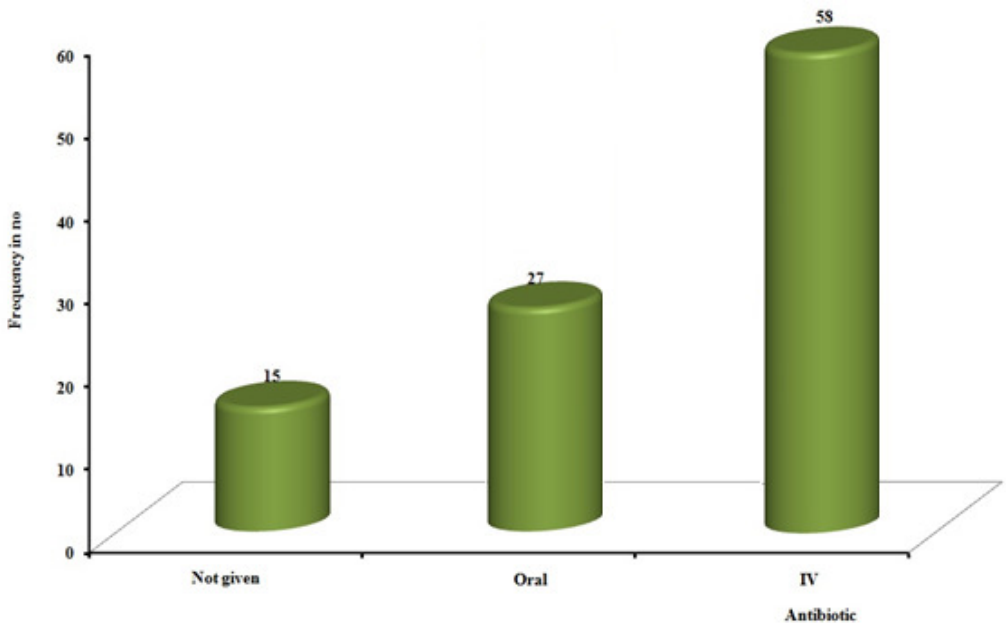
In this study the mid arm circumference was also used to assess the nutritional status. If mid arm circumference is more than 13.5cm it is normal. If it is 12.5cm to 13.5cm then it is borderline. It is wasted if it is less than 12.5cm.

The above chart shows the sex distribution and the grading of nutritional status according to the MAC.

In our study population most of our children fell under the borderline line category that is 12.5 to 13.5. There was no significant difference between the age distribution and MAC grading.



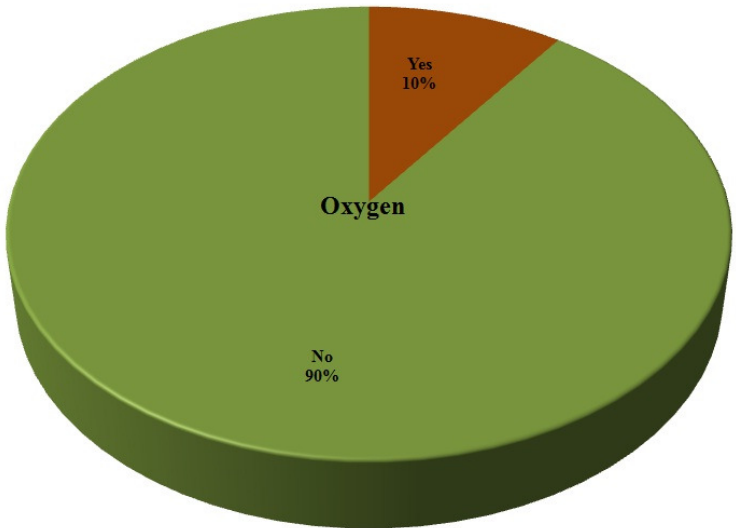
Out of 100 cases of acute lower respiratory tract infections oral antibiotics was given to 58 children and intravenous antibiotics given to 27 children.



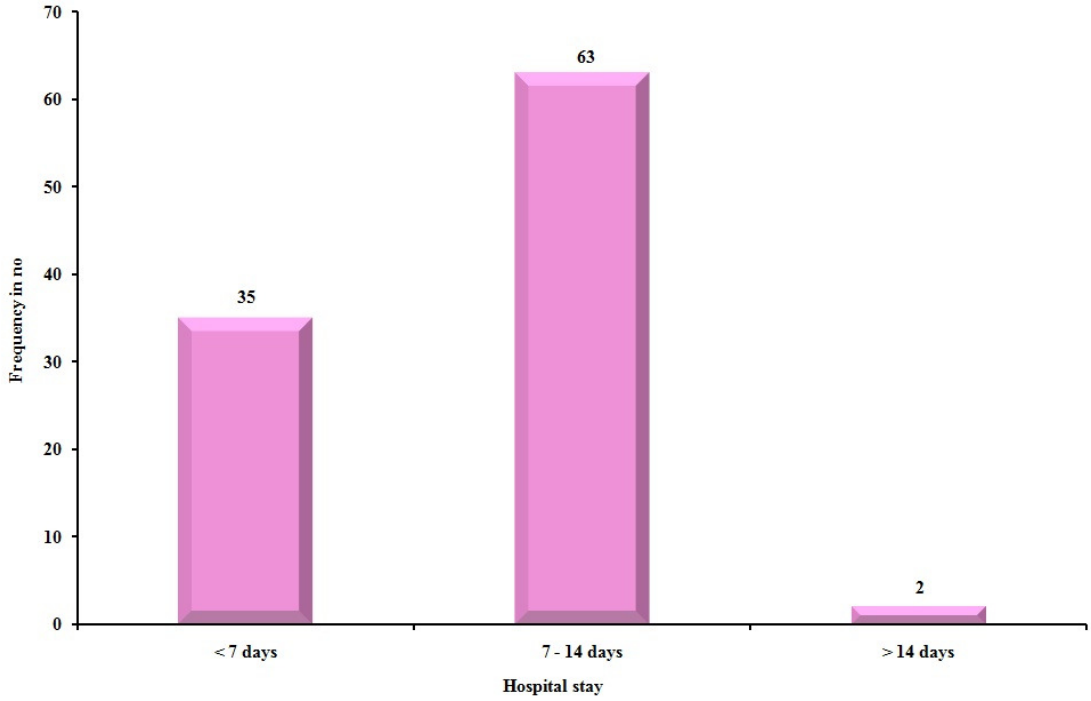
Need of antibiotics in ALRI

For all children with acute lower respiratory tract infections oxygen saturation was checked with a pulse oximeter. Out of 100 cases 7 children had SpO_2 of less than 94%. In the treatment of acute lower respiratory tract infections oxygen was given to 10% of children.

Oxygen requirement in ALRI



Hospital stay for 2 children was more than 14 days. For 63 children hospital stay was 7 to 14 days and for 35 children the duration of hospital stay was less than 7 days.



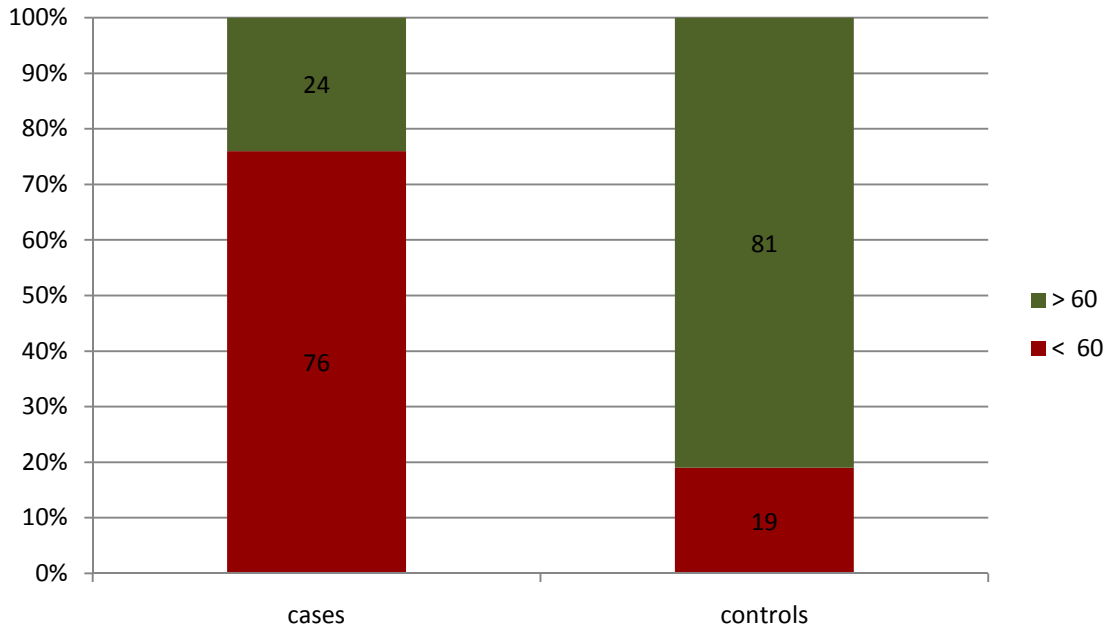
Duration of hospital stay in ALRI

ZINC DEFICIENCY STATUS :

The normal zinc level in serum in children is 60 to 120 µg/ dl.(6) If the serum zinc level is less than 60 µg/ dl then it was taken as zinc deficiency status.

In this study out of 100 cases of acute lower respiratory tract infections, 76% had zinc deficiency status and 24% had normal serum zinc status. In 100 controls 19% had zinc deficiency while 81% had normal zinc levels.

Serum Zinc average	Case	Control
< 60	76	19
> 60	24	81
Total	100	100



Zinc deficiency status in cases and controls

ZINC DEFICIENCY STATUS AND SEX DISTRIBUTION:

Out of 53 male children with acute lower respiratory tract infections, 41 children had zinc deficiency and 12 children had normal zinc levels. Similarly in 53 children taken as controls, 13 children were deficient in zinc. In 47 female children with acute lower respiratory tract infections ,35 children had zinc deficiency and 12 children had normal zinc status. Out of 47 female children taken as controls, 13 were deficient in zinc while 40 had normal zinc levels.

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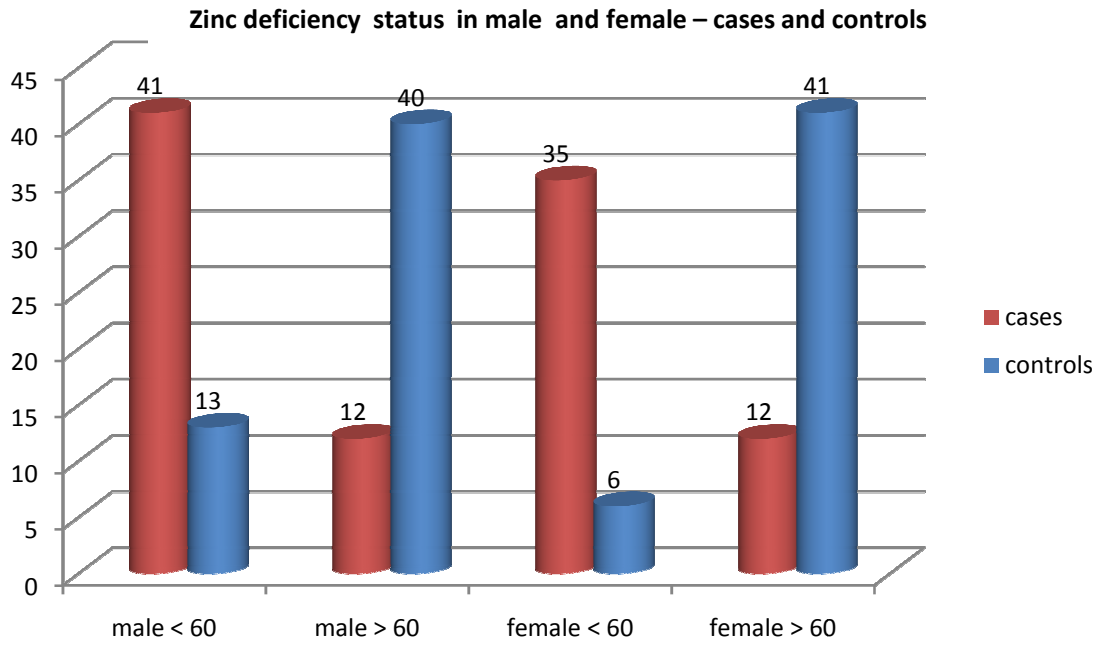
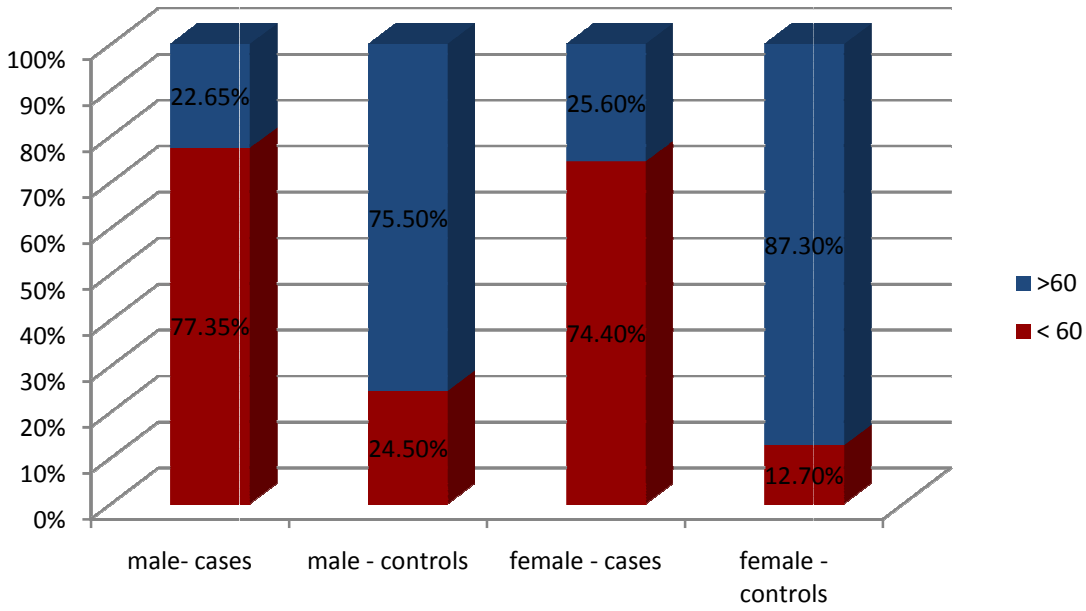
Sex	Case		Control	
	< 60	> 60	< 60	> 60
Male	41	12	13	40
Female	35	12	6	41





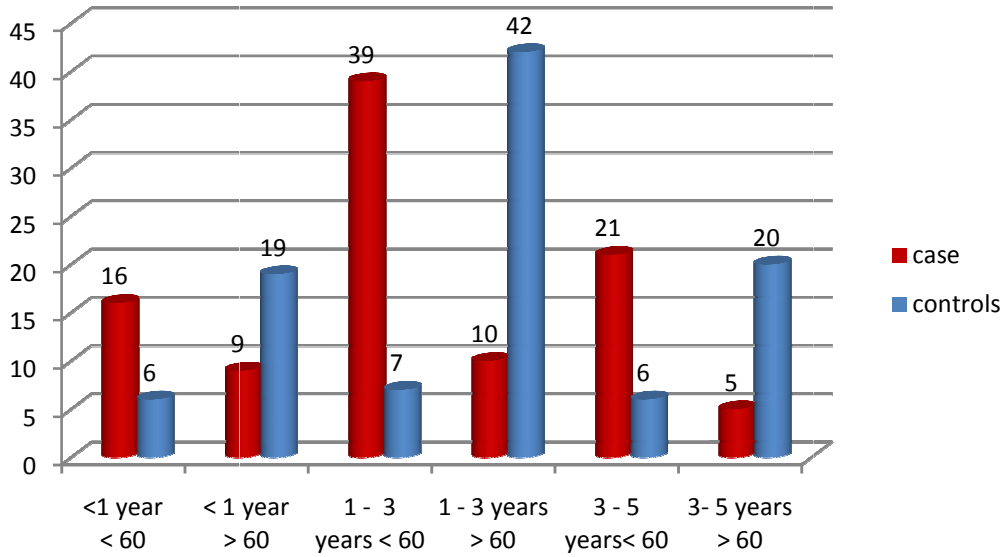
Distribution of zinc deficiency in male and female – cases and controls

Zinc deficiency was 77.35% in male children with ALRI and 24.5% in male controls. Similarly zinc deficiency in female cases was 74.4% and in female controls 12.70%.

ZINC DEFICIENCY IN DIFFERENT AGE GROUPS:

The deficiency status of zinc levels in different age groups is given in the table below. In infants with acute lower respiratory tract infections out of 25 children, 16 cases had zinc deficiency and 9 had normal zinc levels. In infants taken as controls 6 had deficient levels and 19 had normal levels.

In the toddler age group (1 to 3 years) out of 49 cases, 39 were deficient in zinc and 10 had normal zinc levels. In the toddlers taken as controls, 8 had zinc deficiency and 42 had normal zinc levels.



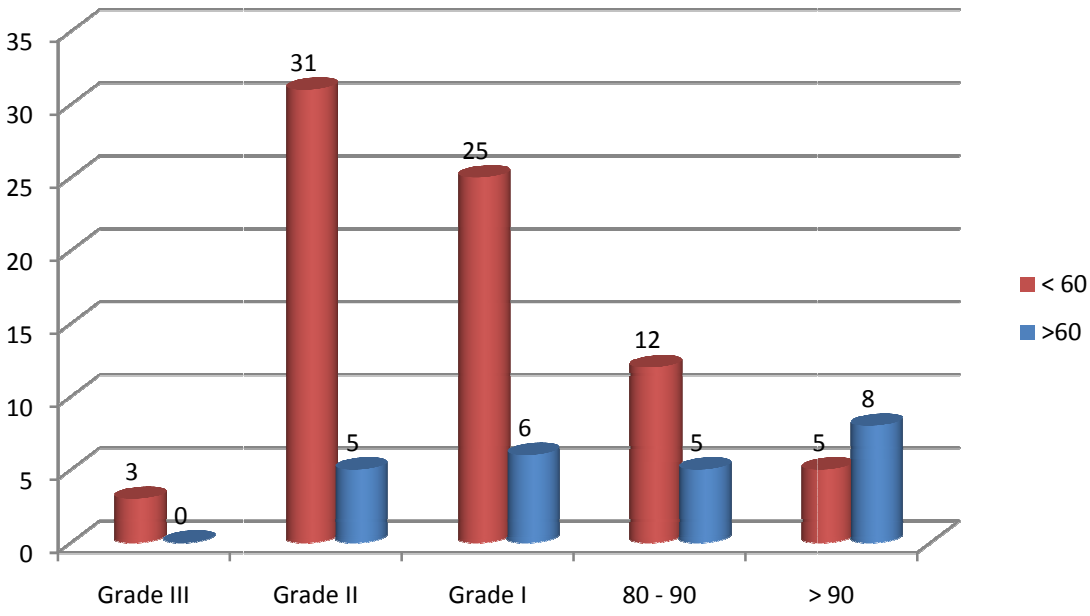
Zinc deficiency in cases and controls - age distribution

In the preschool age group (3 to 5years) out of 26 cases, 21 were zinc deficient and 5 had normal zinc status. In the control group, 5 were deficient in zinc and 20 had normal zinc levels.

Age	Case		Control	
	< 60	> 60	< 60	> 60
< 1	16	9	6	19
1 - 3	39	10	8	42
3 - 5	21	5	5	20

SERUM ZINC DEFICIENCY STATUS AND NUTRITIONAL STATUS:

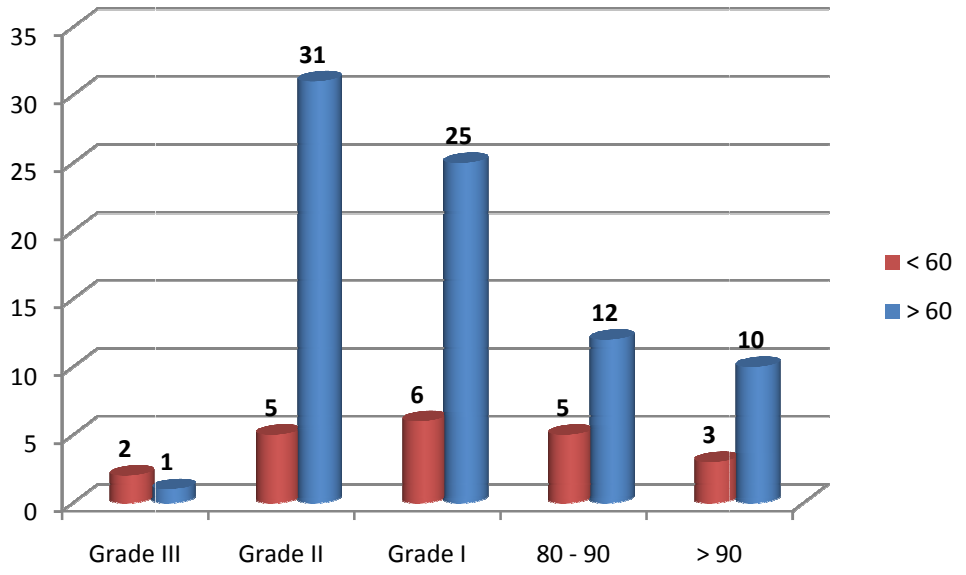
The following chart shows the number of cases with zinc deficiency based on nutritional status(weight for age %).



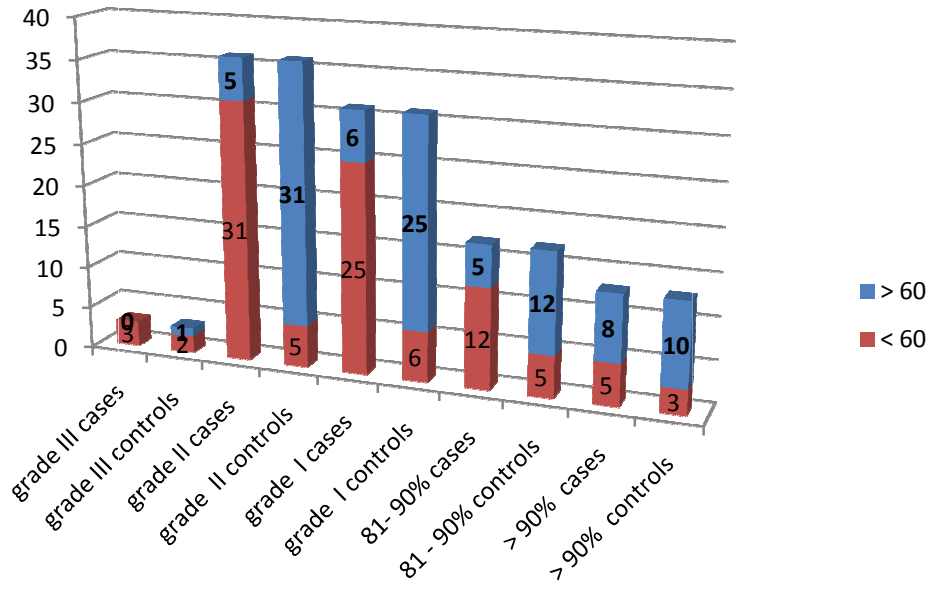
Zinc deficiency status and nutritional status Wt/age% in cases

Wt for age %		Case		Control	
		< 60	> 60	< 60	> 60
Grade III		3	0	2	1
Grade II		31	5	5	31
Grade I		25	6	6	25
Normal	**81 – 90%**	12	5	5	12
	>90%	5	8	3	10

The following chart shows the number of controls with zinc deficiency based on nutritional status (weight for age %).

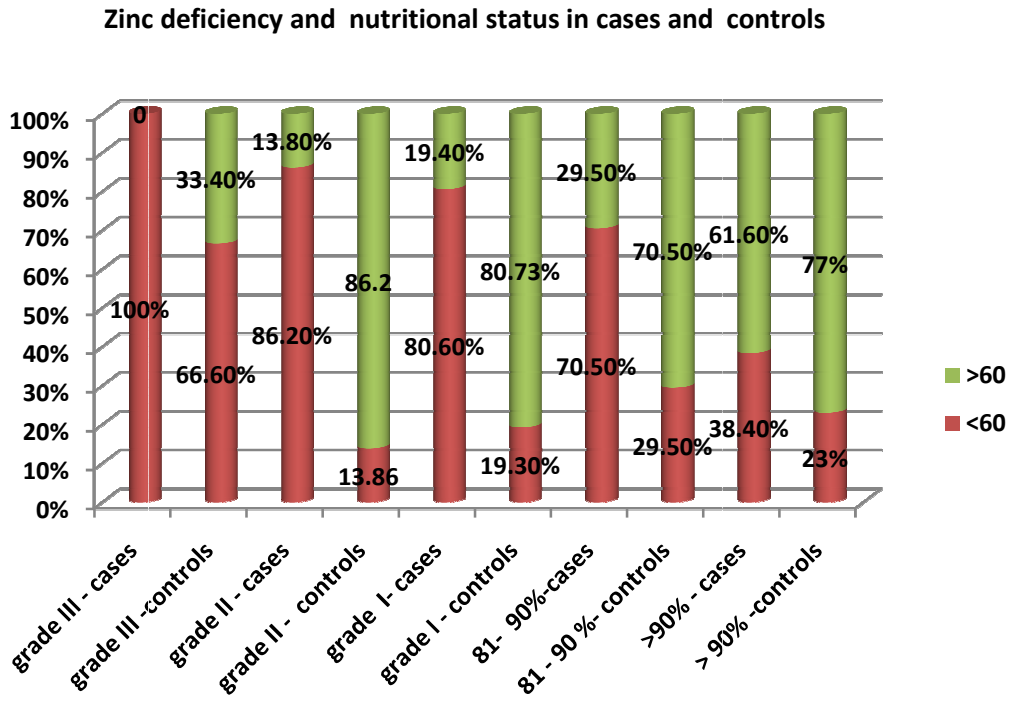


Zinc deficiency status and nutritional status Wt/age% in controls



Zinc deficiency and nutritional status

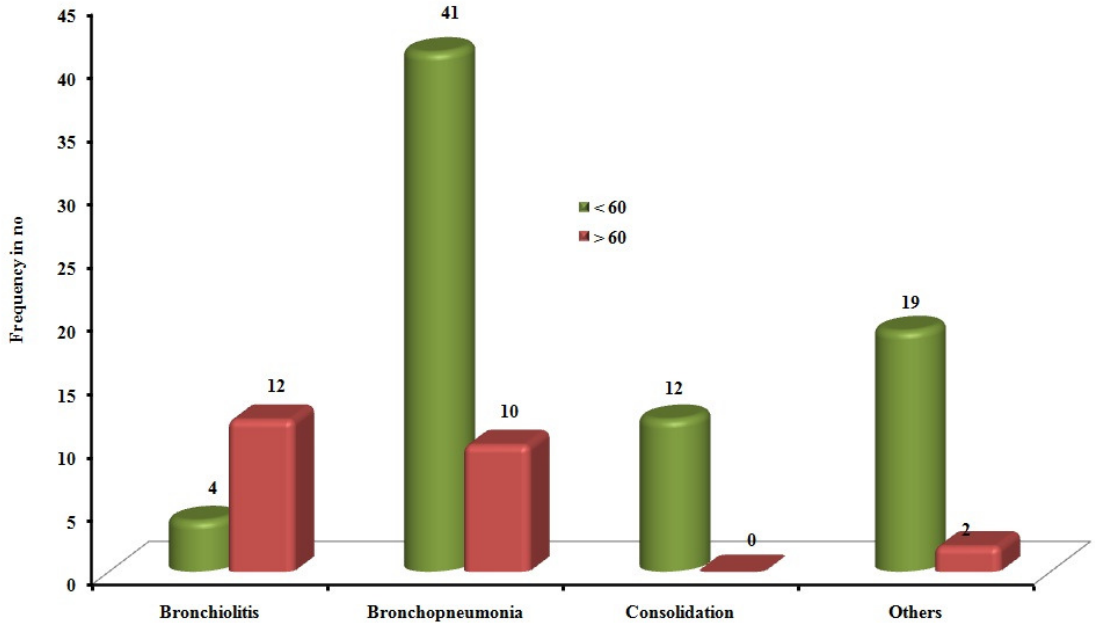
Based on the nutritional status zinc deficiency was seen more in grade III malnutrition in cases and controls. Normal zinc status was seen in more number of children with weight for age% more than 90 %.



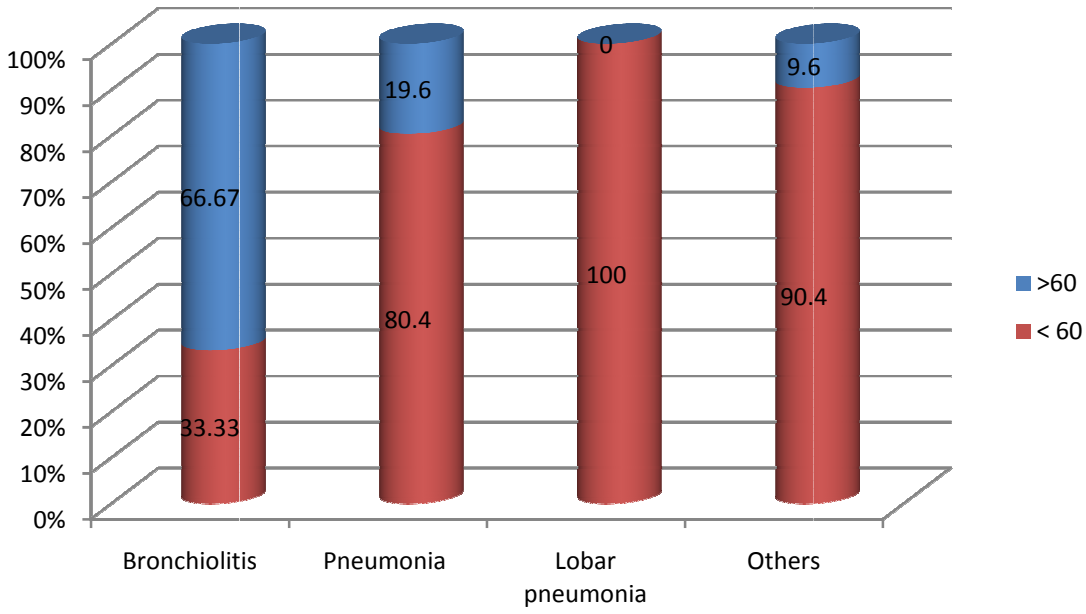
In grade III PEM children with ALRI zinc deficiency was seen in 100% while 66.6 % Grade III controls had zinc deficiency. In grade II PEM 86.2% of cases had zinc deficiency and 13.86% of controls had zinc deficiency In grade I PEM 80.6% of cases had zinc deficiency and 19.3% of controls had zinc deficiency. In normal children with weight for age % 81 – 90%, 70.5 % cases had zinc deficiency and 29.5% of controls had zinc deficiency. In Weight for age % more than 90%, 38.40% of cases had zinc deficiency and 23 % of controls had zinc deficiency.

SERUM ZINC DEFICIENCY STATUS IN VARIOUS DISEASE PATTERNS

The status of zinc deficiency in the various disease patterns of acute lower respiratory tract infections is given in the table below. According to the study zinc deficiency status was seen more in lobar pneumonia, pneumonia and in children with clinical diagnosis of acute lower respiratory tract infections but no radiological abnormality than in bronchiolitis.



Zinc deficiency status and various disease patterns



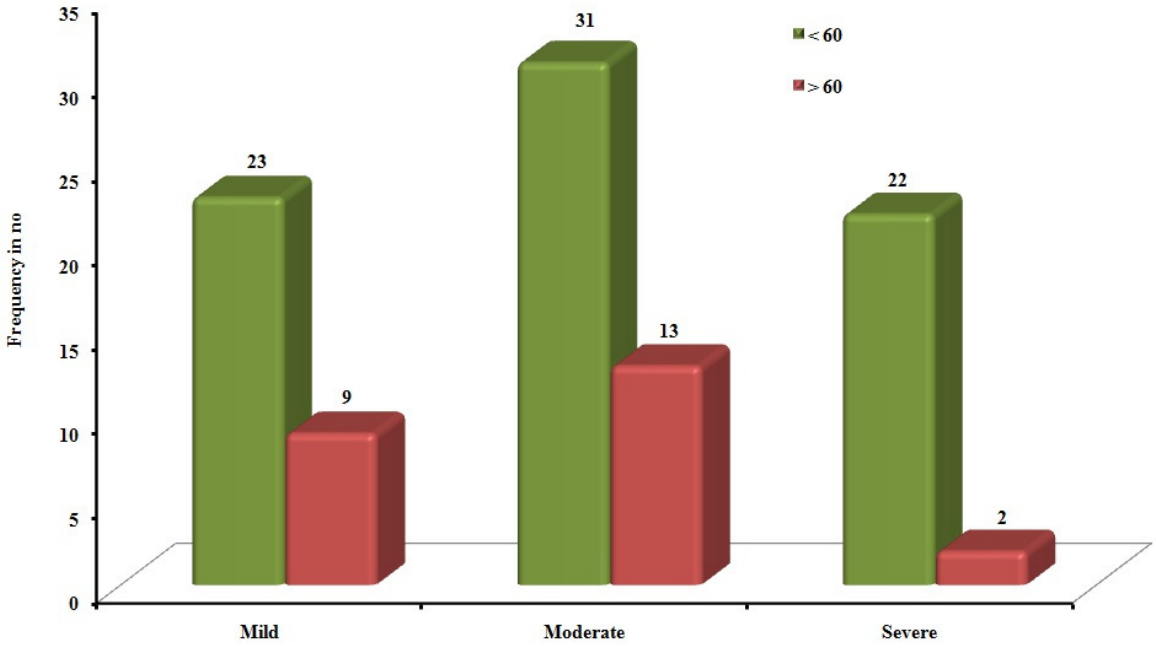
Zinc deficiency in various disease patterns

In bronchiolitis 33.3 % of children had zinc deficiency. In pneumonia 80.4 % of children had zinc deficiency and in ALRI with no radiological abnormality 90.4 % had zinc deficiency.

Diagnosis	Case	
	< 60	> 60
Bronchiolitis	4	12
Pneumonia	41	10
Lobar pneumonia	12	0
Others	19	2

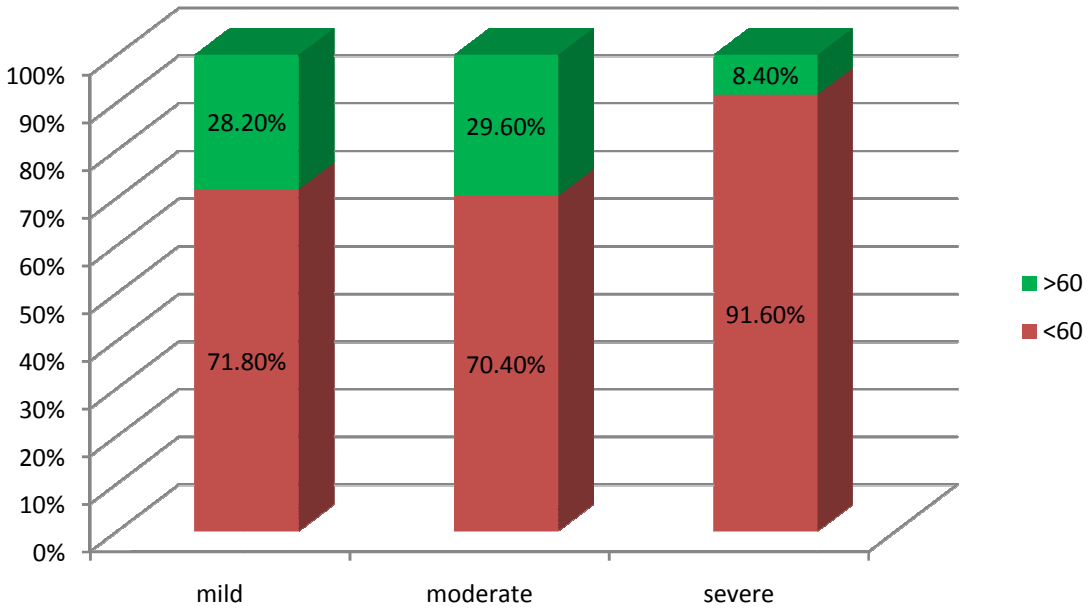
SERUM ZINC DEFICIENCY STATUS AND SEVERITY OF ILLNESS

The number of children with zinc deficiency in mild, moderate and severe acute lower respiratory tract infections is given in the table below. According to this study more number of children in severe acute lower respiratory tract infections were deficient in zinc than the children with moderate and mild acute lower respiratory tract infections.



Zinc deficiency and severity in ALRI

Severity	< 60	> 60
Mild	23	9
Moderate	31	13
Severe	22	2



Zinc deficiency and severity of ALRI

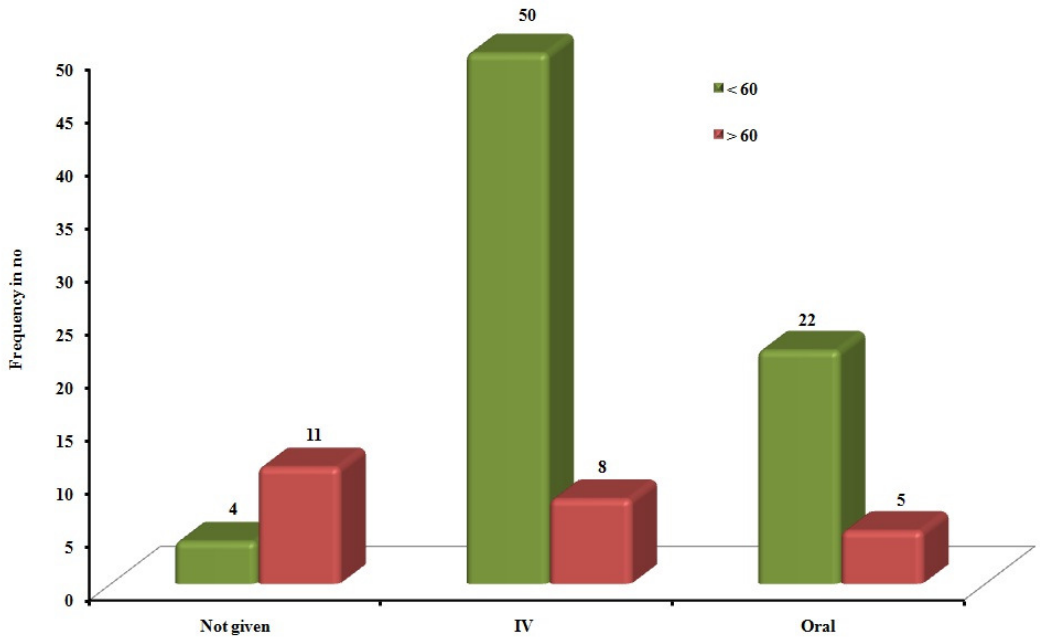
In mild ALRI 71.8 % had zinc deficiency. In moderate ALRI 70.4 % had zinc deficiency and in severe ALRI 91.6% had zinc deficiency.

SERUM ZINC DEFICIENCY STATUS AND ANTIBIOTICS:

In this study zinc deficiency was seen more in children with acute lower respiratory tract infections who needed antibiotics.

Zinc deficiency was seen in more number of children with acute lower respiratory tract infections who needed IV antibiotic than in children who needed oral antibiotics.

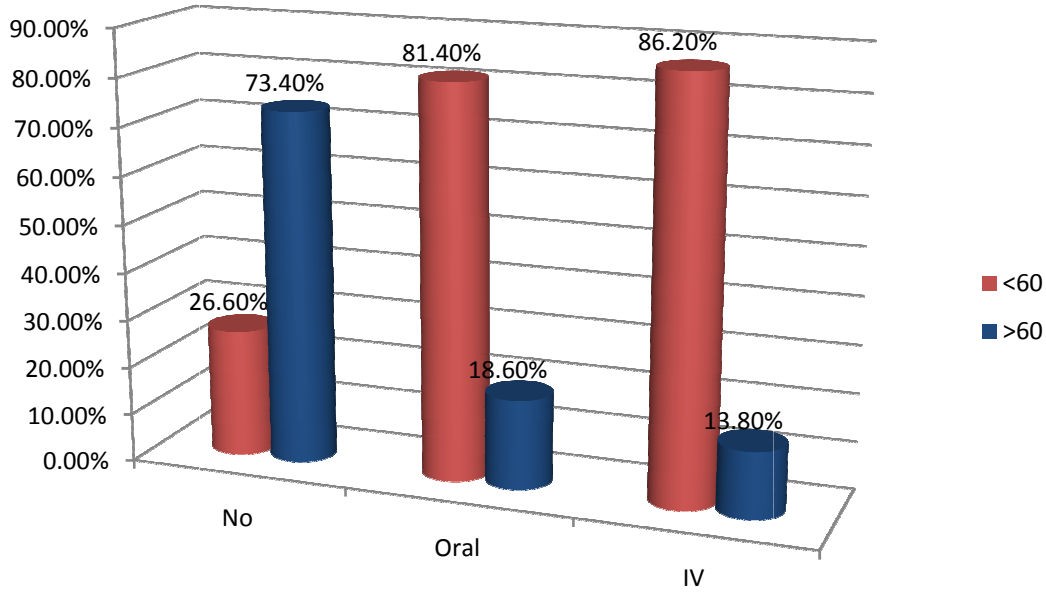
In cases of ALRI who were not given any antibiotic, 26.6% had zinc deficiency. In children who received oral antibiotic, zinc was deficient in 81.4% and in children who received intravenous antibiotics, 86.2 % had zinc deficiency.



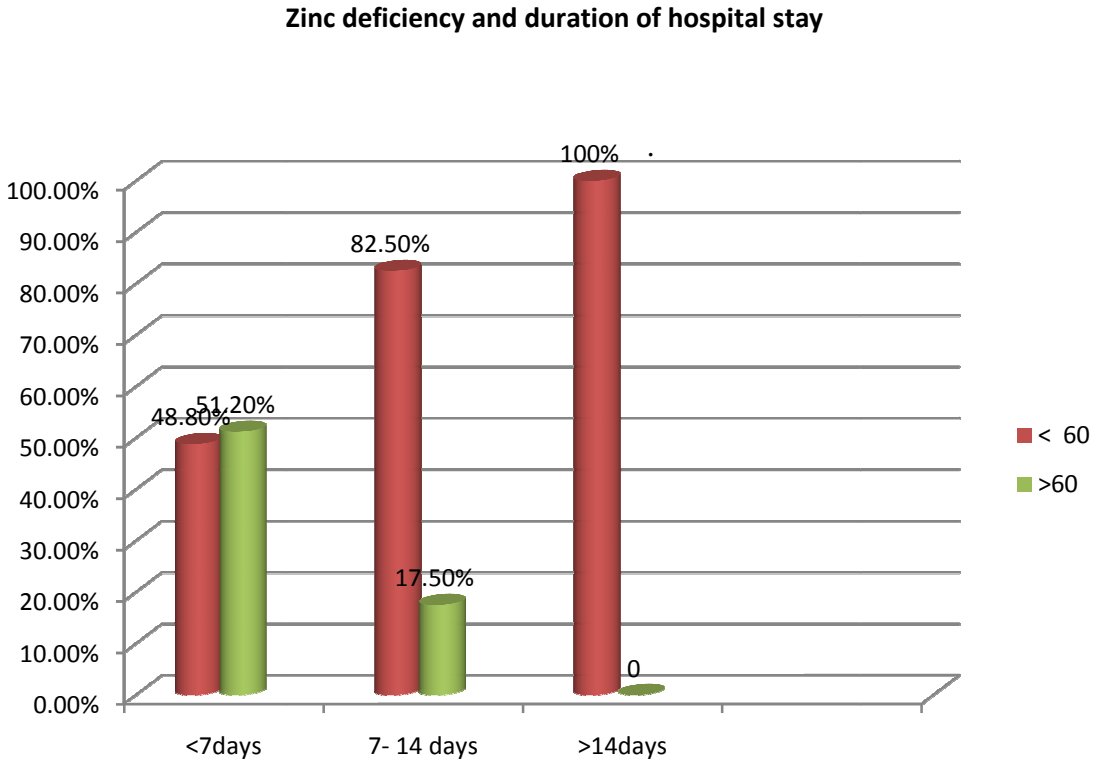
Zinc deficiency and need of antibiotics

Antibiotic	< 60	> 60
Not given	4	11
IV	50	8
Oral	22	5

Zinc deficiency and need of antibiotics

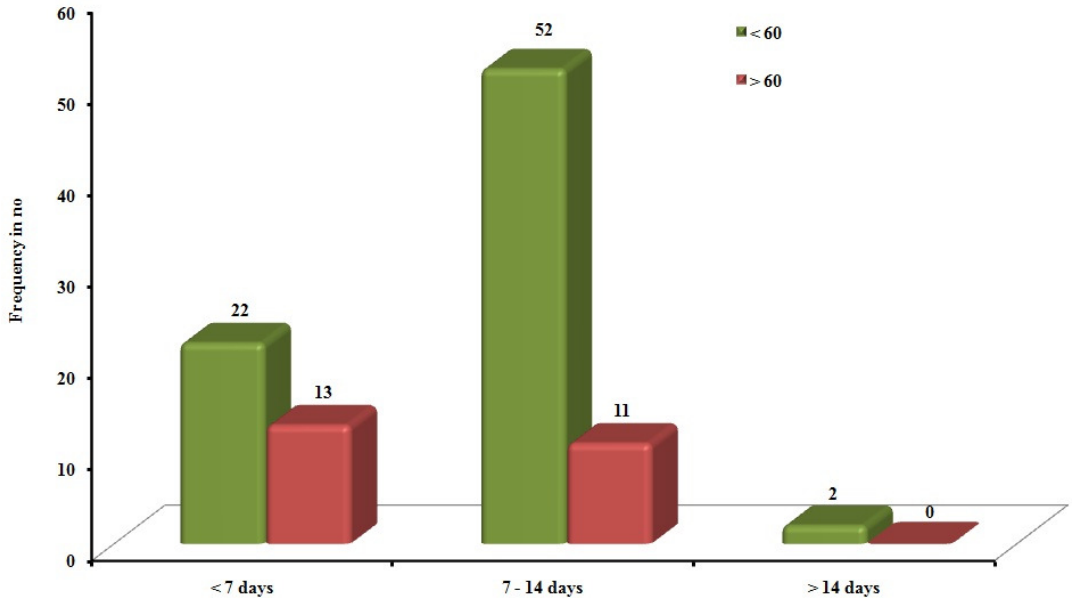


SERUM ZINC DEFICIENCY STATUS AND HOSPITAL STAY



Zinc deficiency status was seen more in children with acute lower respiratory tract infections who needed a prolonged hospital stay. 48.8 % of cases whose hospital stay was < 7 days had zinc deficiency. In cases whose hospital stay was 7 to 14 days, 82.5 % had zinc deficiency and in children with hospital stay >14 days zinc deficiency was seen in 100 % of cases.

Hospital stay	< 60	> 60
< 7 days	22	13
7 - 14 days	52	11
> 14 days	2	0

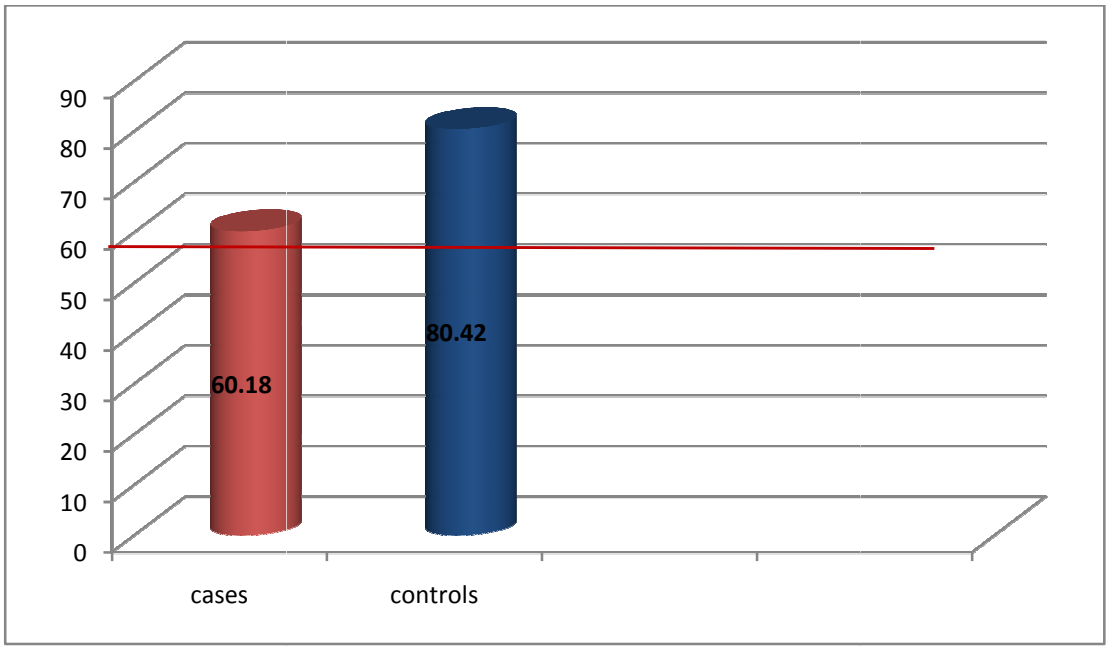


Zinc deficiency and duration of hospital stay

SERUM ZINC STATUS

The mean serum zinc levels in cases was 60.18 µg/dL and in controls was 80.42 µg/dL . The p value was 0.001 which is significant. The association of serum zinc level in both groups is detailed in the table below.

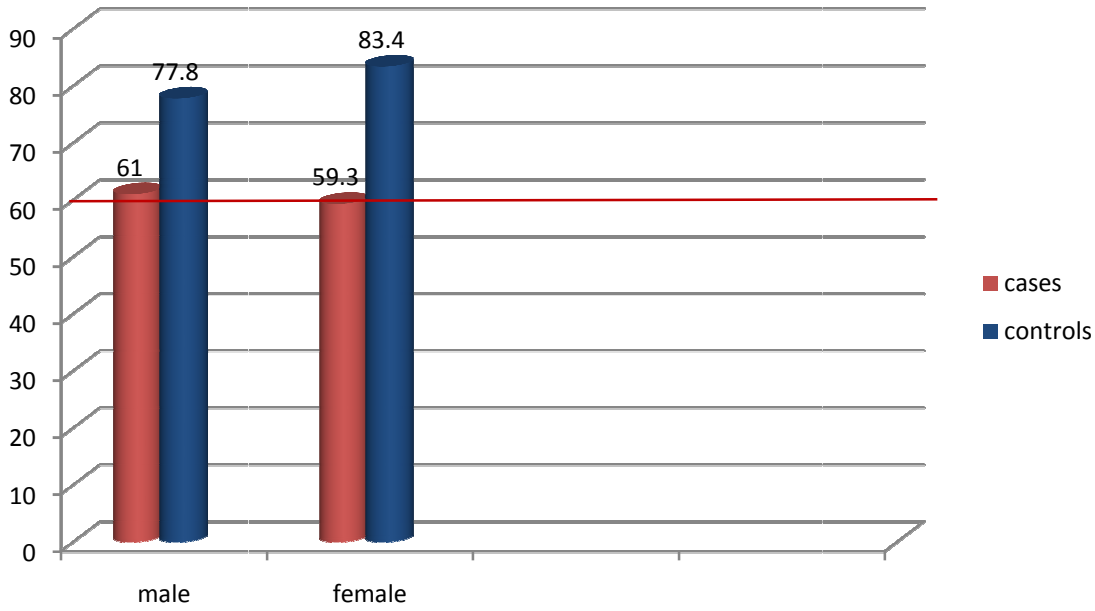
	Mean Serum Zinc	SD	**P-Value**	**Sig**
Case	60.18	14.8		
Control	80.42	18.2	**0.001**	**S**



Mean zinc in cases and controls

Serum Zinc and Sex Distribution:

The association between serum zinc and sex distribution is given in the table below. There were 53 males and 47 females. The mean serum zinc of male cases and female cases were 61 µg/dL and 59.3 µg/dL respectively. The mean serum zinc in male controls and female controls were 77.8 µg/dL and 83.4 µg/dL respectively.



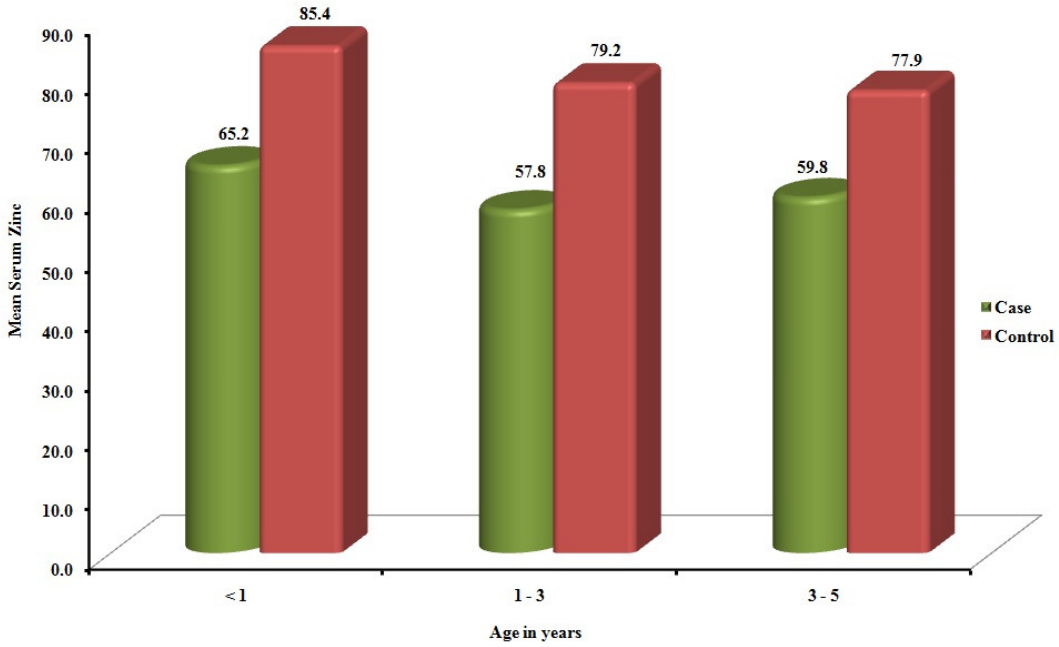
Mean serum zinc in cases and controls

Sex	Male	Female	P-Value	Sig
Case	61.0	59.3	**0.6**	**NS**
Control	77.8	83.4	**0.6**	**NS**

Serum zinc and age distribution:

The mean serum zinc levels in the various age groups are given in the table below. The mean zinc level in cases in age group less than 1 year , 1 to 3 years and 3 to 5 years were 65.2 µg/dL, 57.8 µg/dL and 59.8 µg/dL respectively.

Similarly the mean zinc levels in controls for the age group less than 1 year , 1 to 3 years and 3 to 5 years were 85.4 µg/dL, 79.2 µg/dL and 77.9 µg/dL respectively.



Mean serum zinc level in cases and controls in different age groups

Age	< 1	1 - 3	3 - 5	
Case	65.2	57.8	59.8	NS
Control	85.4	79.2	77.9	NS

SERUM ZINC AND NUTRITIONAL STATUS

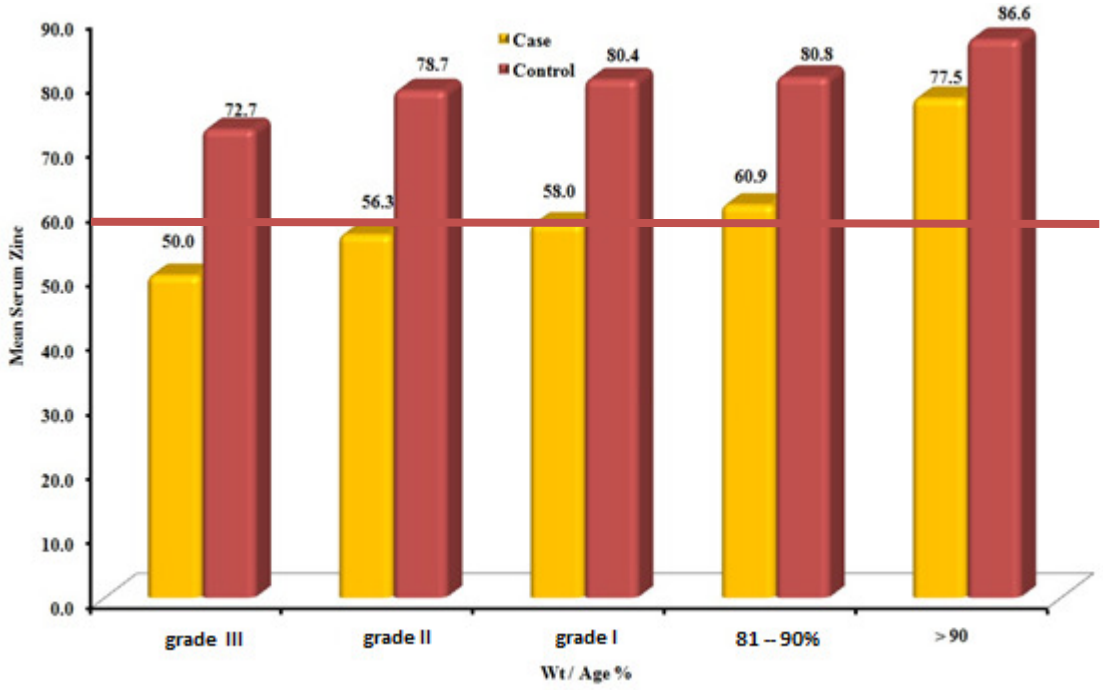
The difference in the mean zinc level in cases and controls were significant in grade I, grade II, grade III and 81 to 90% weight for age %. In weight for age % more than 90 %, the difference between cases and controls was not statistically significant.

Also the difference in zinc levels between 81 to 90 %, grade I, grade II and Grade III malnutrition was not significant when compared to the

difference between weight for age % more than 90 % and the other grades of malnutrition.

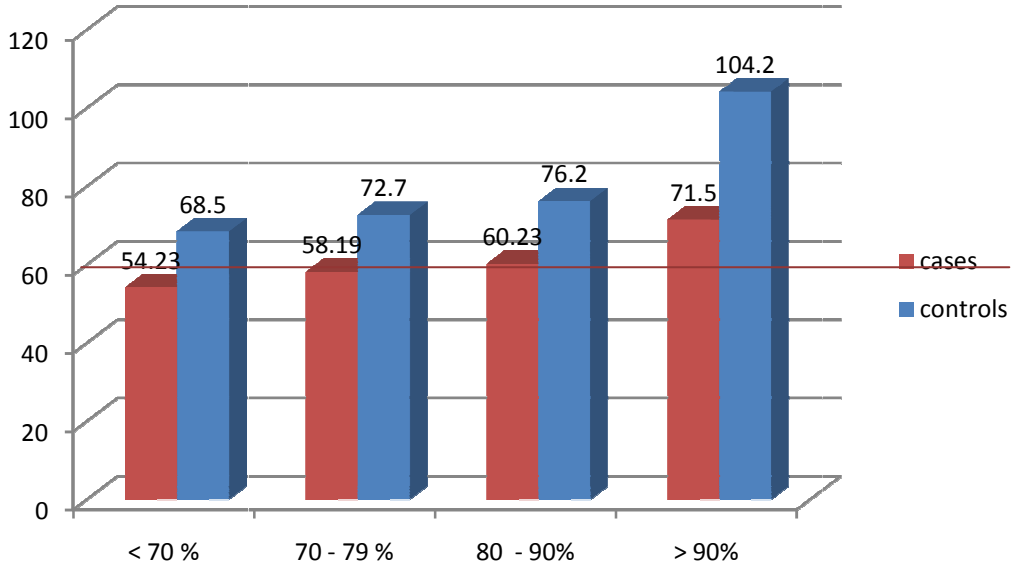
The association between zinc levels of weight for age % in cases and controls is given in the table below.

Wt for age %	No	Case	Control	P-Value	Sig
< 60	**3**	50.0	72.7	**0.004**	**S**
60 - 69	**36**	56.3	78.7	**0.000**	**S**
70 - 79	**31**	58.0	80.4	**0.000**	**S**
80 - 89	**17**	60.9	80.8	**0.002**	**S**
> 90	**13**	77.5	86.6	**0.344**	**NS**



Mean serum zinc levels in cases and controls according to weight /age%

The association between the serum zinc level and weight for height% is shown in the chart below. The difference in zinc levels in mild, moderate and severe wasting was not significant when compared to the difference between normal weight for height % and the other grades of wasting.



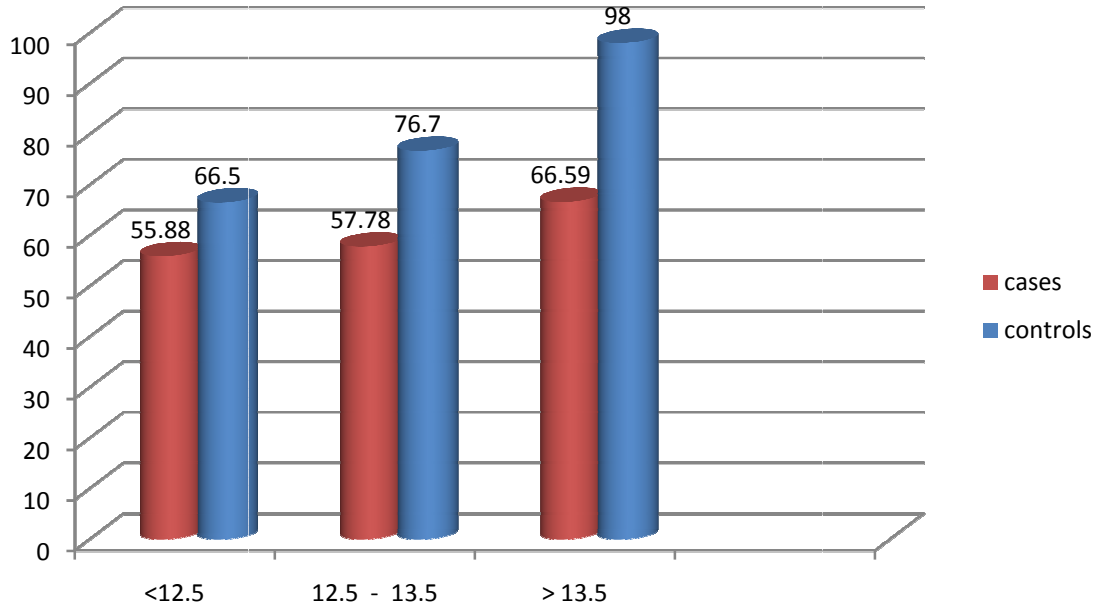
Mean serum zinc in weight/height %

In weight for height % < 70% ,mean zinc was 54.2 in cases and 68.5 in controls. In weight for height % 70 to 79%, mean zinc was 58.19 in cases and 72.7 in controls. In weight for height 80 to 90%, mean zinc was 60.23 in cases and 76.2 in controls. In weight for height % >90% , mean zinc was 71.5 in cases and 104 in controls.

SERUM ZINC STATUS AND MID ARM CIRCUMFERENCE

The association between zinc status and mid arm circumference is given in the chart below. The difference in the zinc level was significant between the normal mid arm circumference and mid arm circumference indicating

malnutrition. But the difference between borderline and wasting was not statistically significant.



Mean serum zinc level and MAC

In MAC < 12.5 cm mean zinc in cases was 55.8 and in controls was 66.5. In MAC 12.5 to 13.5 cm mean zinc in cases was 57.7 and in controls was 76.7. In MAC > 13.5 cm mean zinc was 66.5 in cases and 98 in controls.

SERUM ZINC AND DISEASE PATTERN:

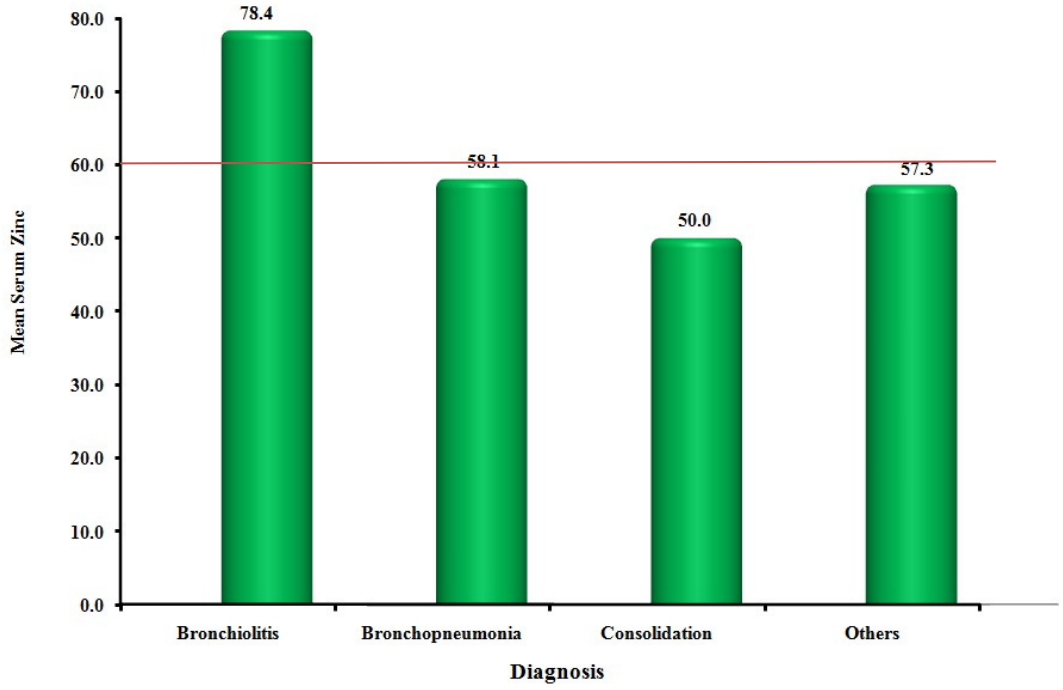
The association between serum zinc level and disease pattern is detailed in the table below. In bronchioltis the mean serum zinc was 78.4 µg/dL which is normal zinc status.

The mean serum zinc levels of bronchopneumonia, lobar pneumonia and acute lower respiratory tract infections with only clinical diagnosis of acute

lower respiratory tract infections were 58.1 µg/dL, 50 µg/dL and 57.3 µg/dL respectively.

However the difference in zinc level between bronchiolitis and the other forms of acute lower respiratory tract infections is statistically significant with p value of 0.001.

Diagnosis	N	Mean of Serum Zinc	P-Value	Sig
Bronchiolitis	**16**	78.4	**0.001**	**S**
Pneumonia	**51**	58.1		
Lobar pneumonia	**12**	50.0		
Others	**21**	57.3		



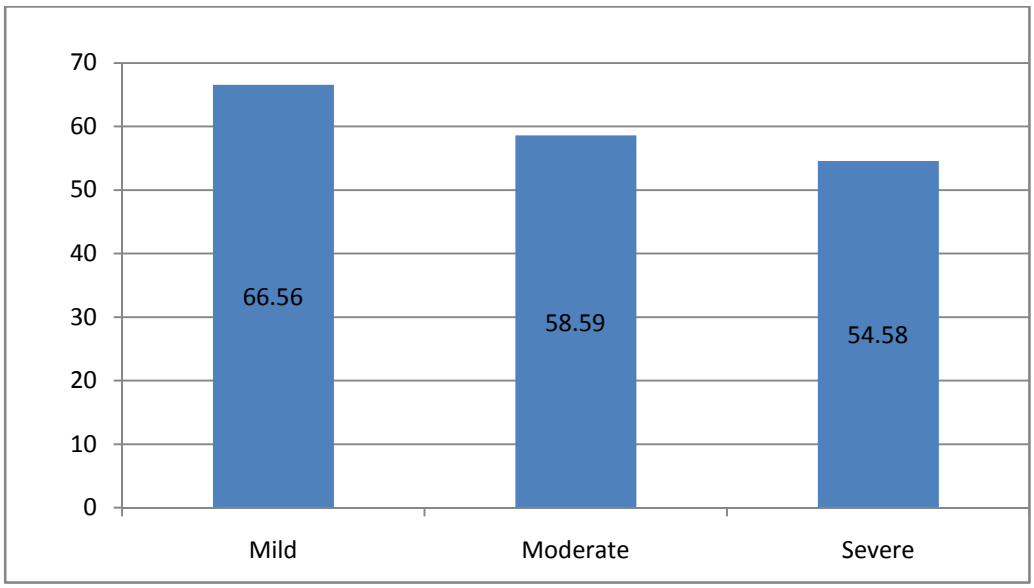
Mean serum zinc level in various disease patterns

SERUM ZINC STATUS AND SEVERITY:

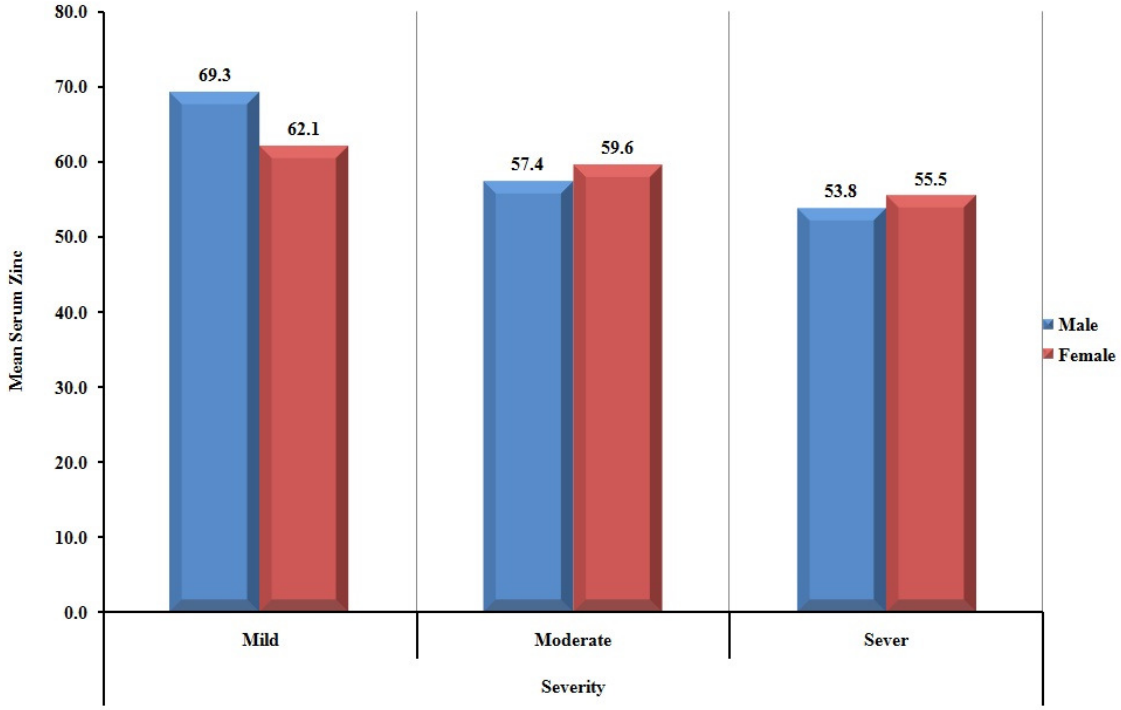
The association between zinc status and severity of acute lower respiratory tract infections is given in the table below . The mean serum zinc of mild moderate and severe acute lower respiratory tract infections were 66.56 µg/dL , 58.59 µg/dL and 54.58 µg/dL respectively.

Serum zinc status between mild acute lower respiratory tract infections and moderate or severe acute lower respiratory tract infections was statistically significant as the p value was 0.007. But the difference between moderate and severe ALRI was not statistically significant.

Severity	No	Mean Serum Zinc	P-Value	Sig
Mild	32	66.56	**0.007**	**S**
Moderate	44	58.59		
Severe	24	54.58		
Total	100	60.18		



Mean serum zinc level according to severity of ALRI



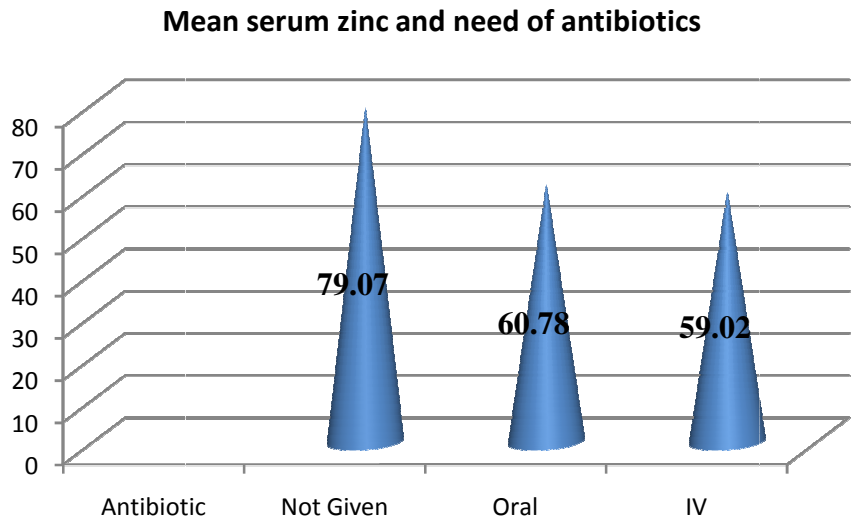
Mean serum zinc level according to severity of ALRI in male and female

SERUM ZINC STATUS AND ANTIBIOTICS:

The mean zinc level in children who needed oral and IV antibiotics were 60.78 µg/dL and 55.02 µg/dL respectively. The mean zinc level in children who did not need antibiotics was 79.07 µg/dL which fell in the normal range of serum zinc level.

Therefore there is a significant association between serum zinc status and the need for antibiotics. The p value is 0.0001 which is statistically significant.

Antibiotic	N	Mean of Serum Zinc	P-Value	Sig
Not given	15	79.07	**0.001**	**S**
IV	58	55.02		
Oral	27	60.78		
Total	100	60.18		



SERUM ZINC STATUS AND SpO_2:

The association between the serum zinc level and SpO_2 is given in the table below. There was not much difference in the zinc level between the children with SpO_2 less than and more than 94 % .

The mean zinc level of children with SpO_2 less than 94%and more than 94 % were 60.7 µg/dL and 60 µg/dL respectively.

SpO2	No	Mean of Serum Zinc
< 94%	7	60.7
> 94%	93	60
Total	100	

The mean serum zinc of children who needed and who did not need oxygen were 62.6 µg/dL and 59.91 µg/dL respectively. The p value is 0.592 and therefore not significant.

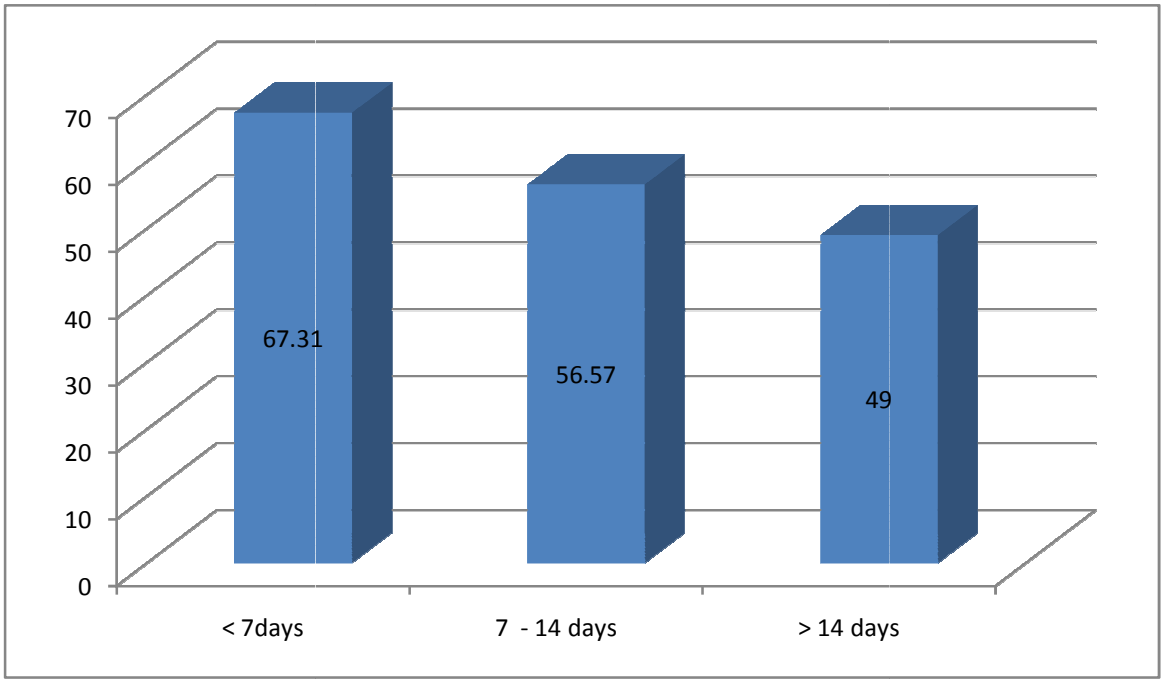
Oxygen	N	Mean of Serum Zinc	P-Value	Sig
Yes	10	62.6	**0.592**	**NS**
No	90	59.91		
Total	100	60.18		

SERUM ZINC STATUS AND DURATION OF HOSPITAL STAY:

The association between the serum zinc level and the duration of hospital stay is given in the table below. The mean zinc level of children with hospital stay less than 7 days, 7 to 14 days and more than 14 days were 67.31 µg/dL, 56.57 µg/dL and 49 µg/dL respectively. The p value is 0.0001 and therefore significant.

The mean zinc level of the children with hospital stay of more than 7 days fell in the deficiency range.

Mean serum zinc and duration of hospital stay



Hospital stay	N	Mean of Serum Zinc	P-Value	Sig
< 7 days	35	67.31	**0.001**	**S**
7 - 14 days	63	56.57		
> 14 days	2	49		
Total	100	60.18		

OBSERVATION

The following observations were made in this case control study done in Government Royapettah Hospital. The total number of study population was 200 which included 100 cases and 100 controls.

Study population included 100 children with acute lower respiratory tract infections in the age group 6 months to 5 years and 100 sex, age and nutritional status matched children were taken as controls.

Among them 53 were male children and 47 were female children. The mean age group in male and in female was 2 years. There were 25 children in the age group less than 1 year , 49 children in 1 to 3 years age group and 26 children in the age group of 3 to 5 years.

Among the 100 cases of acute lower respiratory tract infections 16 cases were bronchiolitis, 51 cases were bronchopneumonia, 12 cases were lobar pneumonia .Among the 100 cases majority of the children were cases of bronchopneumonia.

There were 32 cases of mild acute lower respiratory tract infections, 44 cases of moderate acute lower respiratory tract infections and 24 cases of severe acute lower respiratory tract infections.

Among the 100 cases of acute lower respiratory tract infections most children presented as moderate acute lower respiratory tract infections.

Most of the children were in grade II PEM followed by grade I PEM according to IAP classification. 30 children had normal nourishment, while 31 fell under grade I PEM, 36 fell under grade II PEM and 3 fell under grade III PEM.

Based on Waterlows classification most of the children were in the 80 to 89% group.

Based on the mid arm circumference most of our children fell in the borderline line category that is 12.5 to 13.5.

In the treatment of acute lower respiratory tract infections out of 100 cases of acute lower respiratory tract infections 58 children needed oral antibiotics and 27 children needed intravenous antibiotics. 10% of children needed oxygen.

In this study out of 100 cases of acute lower respiratory tract infections, 76% had zinc deficiency status and 24% had normal serum zinc status. In 100 controls 19% had zinc deficiency while 81% had normal zinc levels.

Zinc deficiency was 77.35% in male children with ALRI and 24.5% in male controls. Similarly zinc deficiency in female cases was 74.4% and in female controls 12.70%

In grade III PEM children with ALRI zinc deficiency was seen in 100% while 66.6 % Grade III controls had zinc deficiency. In grade II PEM 86.2% of cases had zinc deficiency and 13.86% of controls had zinc deficiency In grade I PEM 80.6% of cases had zinc deficiency and 19.3% of controls had zinc deficiency. In normal children with weight for age % 81 – 90%, 70.5 % cases had zinc deficiency and 29.5% of controls had zinc deficiency. In Weight for age % more than 90%, 38.40% of cases had zinc deficiency and 23 % of controls had zinc deficiency.

In bronchiolitis 33.3 % of children had zinc deficiency. In pneumonia 80.4 % of children had zinc deficiency and in ALRI with no radiological abnormality 90.4 % had zinc deficiency.

In mild ALRI 71.8 % had zinc deficiency. In moderate ALRI 70.4 % had zinc deficiency and in severe ALRI 91.6% had zinc deficiency.

In cases of ALRI who were not given any antibiotic 26.6% had zinc deficiency. In children who received oral antibiotics zinc was deficient in 81.4% and in children who received IV antibiotics 86.2 % had zinc deficiency.

48.8 % of cases whose hospital stay was < 7 days had zinc deficiency. In cases whose hospital stay was 7 to 14 days 82.5 % had zinc deficiency and in children with hospital stay >14 days zinc deficiency was seen in 100 % of cases.

On analysing the mean serum zinc, the mean serum zinc level in cases of acute lower respiratory tract infections was lesser than the mean serum zinc level in controls and the difference was significant with p value of 0.001.

There was no statistical difference in mean serum zinc level between male and female and among the different age groups that is less than 1 year, 1 to 3 years and 3 to 5 years.

The difference in mean serum zinc level between cases and controls in grade I, grade II , grade III PEM and 81 to 90 weight for age % was significant where as the difference between cases and controls in weight for age % more than 90 was not significant.

The mean serum zinc level showed a zinc deficiency status in the severe wasting according to Waterlows classification (weight for height %) . The mean zinc level was highest in normal weight for height %.

Based on the mid arm circumference the mean serum zinc level was within the normal limit in normal nutrition status and deficient in borderline malnutrition and wasting.

The mean serum zinc was highest in the children with bronchiolitis and lowest in children with lobar pneumonia.

The mean serum zinc level was inversely proportional to the severity of acute lower respiratory tract infections, the more the severity the lesser the zinc level.

The mean serum zinc level was lowest in the cases who needed intravenous antibiotics. No difference in zinc levels was seen in children who needed oxygen and who did not need oxygen.

Mean serum zinc level was decreased in cases with prolonged hospital stay. The mean zinc level fell in the normal zinc status in children with hospital stay of less than 7 days. Also when comparing cases and controls more cases had zinc deficiency. In bronchiolitis more number of children had a normal zinc level. In pneumonia and lobar pneumonia more number of children had a zinc deficient state.

Also when comparing to mild and moderate acute lower respiratory tract infections more number of children had a zinc deficient status in severe acute lower respiratory tract infections.

DISCUSSION

Acute lower respiratory tract infections is a major cause of mortality and morbidity in children less than 5 years. Therefore it is necessary to take steps to prevent and decrease the severity of respiratory tract infections.

There are many risk factors for acute lower respiratory tract infections. Some of the risk factors include low education, low socioeconomic status, environmental factors, poor housing, poor health care, inadequate vaccination, malnutrition, micronutrient deficiency and demographic factors (age and gender)

Among the micronutrients zinc has been considered to have a role in acute lower respiratory tract infections. Either it has a direct role on the respiratory tract or it has a role in the immune system of the body. It has also got an anti oxidant effect. This may help in reducing the inflammation of the respiratory tract and there by aids in healing and quickens recovery from illnesses.

Also Zinc deficiency has been considered as a risk factor for mortality and Disability Adjusted Life Year (DALY) according to WHO. According to WHO zinc deficiency contributes to 0.7 % of deaths and 1% of Disability Adjusted Life Year(DALY).(33)

Zinc deficiency has been found to be prevalent in developing countries either due to the poor intake of zinc rich food or due to the present of phytate in food substances which decrease the absorption of zinc. Also the lesser zinc content in soil may be one of the reasons for the decreased amount of zinc in food.

Therefore it may be necessary to supplement zinc to prevent and to decrease the severity of acute lower respiratory tract infections.

There are many studies showing zinc supplementation in decreasing the number of episodes of acute lower respiratory tract infections. In some studies zinc deficiency or a low zinc status is seen in acute lower respiratory tract infections or pneumonia.

In this study 53 were male and 47 were female. There were 16 % of bronchiolitis , 57 % of pneumonia and 12% of lobar pneumonia. 32% had mild ALRI, 44% had moderate ALRI and 24% had severe ARLI.

In this study serum zinc level was low in children with acute lower respiratory tract infections when compared to controls who were matched with age, sex and nutritional status.

The mean serum zinc levels in this study in cases was 60.18 µg/dL $\pm$14.8 µg/dL with CI of 45.38 and 74.98 and in controls was 80.42 µg/dL $\pm$ 18.2 with CI of 62.22 and 98.62. with p value of 0.001.

This can be compared with a study in Bangladesh conducted by Shakur M S et al which showed mean serum zinc of 85 $\pm$ 47 (58-152) in cases of acute lower respiratory tract infections when compared to mean serum zinc of 121 µg/dL $\pm$ 48 (68-175) in controls

The mean serum zinc was highest in children with bronchiolitis and lowest in children with lobar pneumonia.

The mean serum zinc level was inversely proportional to the severity of acute lower respiratory tract infections, the more the severity the lesser the zinc level.

The mean serum zinc level was lowest in the cases who needed intravenous antibiotics. No difference in zinc levels was seen in children who needed oxygen and who did not need oxygen.

Mean serum zinc level was decreased in cases with prolonged hospital stay. The mean zinc level fell in the normal zinc status in children with hospital stay of less than 7 days.

Zinc deficiency was seen in 76 % of cases and 19 % of controls. In bronchiolitis 33.3 % of children had zinc deficiency. In pneumonia 80.4 % of children had zinc deficiency and in ALRI with no radiological abnormality 90.4 % had zinc deficiency.

In mild ALRI 71.8 % had zinc deficiency. In moderate ALRI 70.4 % had zinc deficiency and in severe ALRI 91.6% had zinc deficiency. In cases of ALRI who were not given any antibiotic 26.6% had zinc deficiency. In children who received oral antibiotic zinc was deficient in 81.4% and in children who received IV antibiotics 86.2 % had zinc deficiency.

48.8 % of cases whose hospital stay was < 7 days had zinc deficiency. In cases whose hospital stay was 7 to 14 days 82.5 % had zinc deficiency and in children with hospital stay >14 days zinc deficiency seen in 100 % of cases.

CONCLUSION

In this study out of 100 cases, 53 were male and 47 female. 16 % of cases were bronchiolitis , 51% cases pneumonia and 12 cases were lobar pneumonia.32% had mild ALRI, 44% had moderate ALRI and 24% had severe ARLI.

Zinc was deficient in 76% of cases and 19% of controls. Zinc was deficient in 33.33% of children with bronchiolitis and 80.4% of pneumonia and 100 % of lobar pneumonia. Zinc deficiency seen in more number (91.6%) of severe ALRI

Zinc deficiency was seen in 86.2 % of cases who needed IV antibiotics and 81.40% of children who needed oral antibiotics . In cases who did not need any antibiotics 26.6% were deficient in zinc.

Also children with hospital stay of >14 days were 100% deficient and 82.5% of children with hospital stay 7 to 14 days had zinc deficiency and 48.8% of cases with hospital stay < 7 days had zinc deficiency.

Serum zinc level was deficient in children with acute lower respiratory tract infections when compared to children taken as controls. Low serum zinc was seen in malnutrition. But in children with PEM and acute lower respiratory tract infections serum zinc was still more lower.

Serum zinc level was also related to the severity of acute lower respiratory tract infections and the duration of hospital stay. Serum zinc was low in severe acute lower respiratory tract infections when compared to mild and moderate acute lower respiratory tract infections . Also the serum zinc level was deficient in children who need a prolonged hospital stay.

Also there are many studies showing zinc supplementation as a preventive measure of acute lower respiratory tract infections and also as a measure in decreasing the severity of acute lower respiratory tract infections.

Therefore measures should be taken to prevent the zinc deficiency status by

- Promotion of breast feeding
- Proper introduction of complementary feeds
- Improving the dietary habits like improving the increase in animal protein and decreased intake of phytate containing food and
- Zinc supplementation if necessary.

There by we can decrease the incidence and severity of acute lower respiratory tract infections and thereby reduce the under five mortality.

BIBLIOGRAPHY

1. Chang AB, Chang CC, Grady KO et al. Lower respiratory tract infections. Pediatr Clin N Am 2009;56:1303-1321.
2. Ekalaksananan T, Pientong C, Kongyingyoes B et al. Etiology of acute lower respiratory tract infection in children at Srinagarind Hospital, Khon Kaen, Thailand. Southeast Asian J Trop Med Public Health 2001;vol 32(3).
3. Prajapati B, Talsania N,Sonaliya K. A study on prevalence of acute respiratory tract infections(ARI) in under five children in urban and rural communities of Ahmedabad district, Gujarat: National Journal of Community Medicine Vol 2 Issue 2 July-Sept 2011
4. Kalaiselvi S, Gupta SK. Does zinc supplementation prevent acute lower respiratory tract infections in children? The National Medical Journal of India 2011; vol24(5).
5. Nelson textbook of Pediatrics. 18th Edition
6. Serum zinc and magnesium level in patients with liver cirrhosis. Program No. P1336. ACG 2012 Annual Scientific Meeting Abstracts. Las Vegas, NV: American College of Gastroenterology.
7. Cuevas LE, Koyanagi AI. Zinc and infection: a review. Annals of Tropical Paediatrics 2005;25:149-160.
8. Bhatnagar S, Moulinatchu UC. Zinc in child health and disease. Indian Journal of Pediatrics 2004; vol71(11):991-995.
9. Roth DE, Richard SA, Black RE. Zinc supplementation for the prevention of acute lower respiratory infection in children in developing countries:

meta-analysis and meta-regression of randomized trials. International Journal of Epidemiology 2010;39:795-808.

10. Mathew JL, Patwari AK, Gupta P et al. Acute respiratory infection and pneumonia in India: a systematic review of literature for advocacy and action: UNICEF-PHFI series on newborn and child health, India. Indian Pediatrics 2011; vol48.
11. PHC(Project Healthy Children): overview of zinc.
12. Plum LM, Rink L, Haase H. The essential toxin: impact of zinc on human health. Int J Environ Res Public Health 2010;7:1342-1365.
13. IZiNCG: Zinc- recommended nutrient intakes for Malaysia 2005.
14. Bhowmik D, Chiranjib, Sampath kumar KP. A potential medicinal importance of zinc in human health and chronic disease. Int J Pharm Biomed Sci 2010;1:5-11.
15. Prasad AS. Impact of the discovery of human zinc deficiency on health. Journal of American college of Nutrition 2009;3:257-265.
16. Vitamin and mineral requirements in Human nutrition, WHO/FAO of the united nations.
17. Chang AB, Torzillo PJ, Boyce NC et al. Zinc and Vitamin A supplementation in Indigenous Australian children hospitalised with lower respiratory tract infection: a randomised controlled trial. MJA 2006;184:107-112.
18. Dardenne M. Zinc and Immune function. European Journal of Clinical Nutrition 2002;56(suppl 3):s20-s23.
19. Victoria CG. Risk factors for acute lower respiratory infections.

20. The World Health Report 2002: Reducing Risks, Promoting Healthy Life. World Health Organization 2002. ISBN 92 4 156207 2.
21. Shakur MS, Malek MA, Bano N et al. Zinc status in well nourished Bangladeshi children suffering from acute lower respiratory infection. Indian Pediatrics 2004; vol41.
22. Shakur M S, Malek M A, Bano N et al. Serum and Hair Zinc in Severely Malnourished Bangladeshi Children Associated with or without Acute Lower Respiratory Infection. Indian Journal of Pediatrics, Volume 76—June, 2009
23. Arica S, Arica V, Dag H et al. Serum Zinc levels in children of 0-24 months diagnosed with pneumonia admitted to our clinic. Int J Clin Exp Med 2011;4(3):227-233.
24. Pushpa, Lohano M, Memon M. Association of serum zinc level with severe pneumonia in children. Pakistan Journal of Nutrition2009; 8(12):1873-1876.
25. Wahed MA, Islam MAU. Effect of micronutrients on morbidity and duration of hospital stay in childhood pneumonia. The ORION Medical Journal 2008;29:519-523.
26. Javed F, Asghar A, Sheikh S et al. Comparison of serum zinc levels between healthy and malnourished children. APMC 2009; vol3(2).
27. Coles CL, Sherchand JB, Khatry SK et al. Zinc modifies the association between nasopharyngeal streptococcus pneumonia carriage and risk of acute lower respiratory infection among young children in rural Nepal. Journal of Nutrition 2008; 138:2462-2467.

28. Kumar S, Awasthi S, Jain A et al. Blood zinc levels in children hospitalized with severe pneumonia: a case control study. Indian Pediatrics 2004; vol 41:486-491.
29. Brooks WA, Yunus M, Santosham M, et al. Zinc for severe pneumonia in very young children: double blind placebo controlled trial. Lancet. 2004;363:1683–8.
30. Mahalanbis D, Lahiri M, Paul D, et al. Randomised double blind placebo controlled clinical trial of the efficacy of treatment with zinc or vitamin A in infants and young children with severe ARI. Am J Clin Nutr. 2004;79:430–6.
31. Akita Abe, Yiamashita, S., (1989) Clin. Chem. 35/4: 552 554.
32. Tetsuo Makino, (1991) Clin. Chem. Acta. 197:209-220.
33. www.who.int/healthinfo/global_burden_disease/GlobalHealthRisks_report_part2.pdf

Serum Zinc levels in ALRI

Name : Age : Sex : IP.NO.:

Address:

Diagnosis :

Wt : Ht : MAC:

Severity :

Cough: _____days Dyspnea: _____ days

Fever : _____ days Others :

RS: SpO2: HR: RR:

X – Ray :

O2 : yes/ no

Antibiotics : yes/ no If yes : oral / IV - _____

Other treatment:

Duration of hospital stay:

SERUM ZINC :

SNO	age	sex	DIAGNOSIS	severity	serum zinc level	wt(kg)	ht(cm)	MAC(cm)	SPO2	O2	Antibiotics	stay(days)
1	7M	M	Bronchiolitis	Mild	118	7	68	14.2	> 94%	no	nil	<7 days
2	7M	M	Bronchiolitis	Moderate	78	7.3	68	14.1	> 94%	no	nil	<7 days
3	6M	M	Bronchiolitis	Mild	121	6.3	66	14.3	> 94%	no	nil	<7 days
4	8M	M	pneumonia	Moderate	52	6.5	68	13.5	> 94%	no	IV	7 - 14 days
5	8M	M	Bronchiolitis	Severe	90	7.7	68	13.4	> 94%	Yes	nil	7 - 14 days
6	9M	M	pneumonia	Moderate	51	6	68	12.4	> 94%	no	IV	7 - 14 days
7	11M	M	Bronchiolitis	Severe	58	8.2	70	13.6	<94%	yes	nil	7 - 14 days
8	9M	M	Others	Mild	53	7	69	13.6	> 94%	no	ORAL	<7 days
9	10M	M	pneumonia	Mild	55	7	70	13	> 94%	no	ORAL	<7 days
10	10M	M	pneumonia	Moderate	54	6	69.5	12.5	> 94%	no	IV	7 - 14 days
11	11M	M	Others	Mild	56	7.5	71	12.6	> 94%	no	ORAL	<7 days
12	11M	M	Consolidation	Severe	45	5.8	69.5	12.5	> 94%	no	IV	>14 days
13	9M	M	pneumonia	Severe	52	5.7	68	12.5	> 94%	no	IV	7 - 14 days
14	1 3/4	M	Bronchiolitis	Mild	108	10	82.5	13.6	> 94%	no	nil	<7 days
15	2 3/4	M	Consolidation	Severe	52	8	90	13	> 94%	no	IV	7 - 14 days
16	2 1/2	M	Others	Mild	54	9.5	89	13	> 94%	no	ORAL	<7 days
17	2 1/4	M	pneumonia	Mild	99	8	84	13.2	> 94%	no	ORAL	<7 days
18	1 1/4	M	Consolidation	Severe	44	7.5	76	13.2	<94%	yes	IV	7 - 14 days
19	1 1/4	M	Bronchiolitis	Severe	56	7.5	76.5	13.1	<94%	Yes	nil	7 - 14 days
20	2	M	Others	Mild	52	8	87	12.6	> 94%	no	ORAL	<7 days
21	1 1/2	M	Bronchiolitis	Moderate	74	8.5	81	12.5	> 94%	no	nil	<7 days
22	2 1/2	M	pneumonia	Moderate	53	8	88	12.7	> 94%	no	IV	7 - 14 days
23	2 1/2	M	Others	Mild	49	11	90	13.6	> 94%	no	ORAL	<7 days
24	2 3/4	M	pneumonia	Moderate	57	8.5	91	13	> 94%	no	IV	7 - 14 days

25	1 1/2	M	Bronchiolitis	Moderate	72	9.5	80	13.2	> 94%	no	nil	7 - 14 days
26	2 1/2	M	Consolidation	Severe	54	8.5	88	12.3	> 94%	no	IV	7 - 14 days
27	2 3/4	M	Others	Mild	54	11	93	14	> 94%	no	ORAL	<7 days
28	2 1/2	M	pneumonia	Moderate	49	7.5	84	12.6	> 94%	no	IV	7 - 14 days
29	2	M	Others	Mild	53	10	86	13.6	> 94%	no	ORAL	<7 days
30	1 1/4	M	Bronchiolitis	Moderate	64	9	77	13.5	> 94%	no	nil	<7 days
31	1 1/2	M	Bronchiolitis	Severe	53	9	80	14	<94%	yes	nil	7 - 14 days
32	2	M	Others	Moderate	50	8	85	13	> 94%	no	IV	7 - 14 days
33	1 3/4	M	Consolidation	Severe	55	7.5	80	13.4	> 94%	no	IV	7 - 14 days
34	2 3/4	M	Others	Mild	56	11	93	13.6	> 94%	no	ORAL	<7 days
35	2	M	pneumonia	Moderate	52	8	84	12.5	> 94%	no	IV	7 - 14 days
36	1.5	M	Consolidation	Severe	44	7	79	12.4	> 94%	no	IV	7 - 14 days
37	2.5	M	Others	Mild	57	8	88	12.7	> 94%	no	ORAL	<7 days
38	3	M	pneumonia	Moderate	51	10	89	13	> 94%	no	IV	7 - 14 days
39	1	M	pneumonia	Severe	52	8	72	13	> 94%	no	IV	7 - 14 days
40	3	M	Others	Mild	56	10	88	13.3	> 94%	no	ORAL	<7 days
41	3	M	pneumonia	Moderate	53	9	88	12.7	> 94%	no	IV	7 - 14 days
42	3 1/2	M	pneumonia	Moderate	56	10	90	13.1	> 94%	no	IV	7 - 14 days
43	4	M	Others	Mild	58	13	99	13.6	> 94%	no	ORAL	<7 days
44	4	M	pneumonia	Mild	53	11	98	13.1	> 94%	no	IV	7 - 14 days
45	4 1/2	M	Others	Mild	55	13	100	13.7	> 94%	no	ORAL	<7 days
46	4 1/2	M	pneumonia	Mild	89	11	99	12.5	> 94%	no	IV	7 - 14 days
47	3	M	pneumonia	Moderate	54	10	88	13.2	> 94%	no	IV	7 - 14 days
48	3	M	pneumonia	Severe	45	10	88	13.3	> 94%	no	IV	7 - 14 days
49	3 1/2	M	Others	Mild	89	11	89	13.4	> 94%	no	ORAL	<7 days

50	3 3/4	M	pneumonia	Moderate	55	9	90	12.6	> 94%	no	IV	7 - 14 days
51	4	M	pneumonia	Moderate	68	11	94	13.1	> 94%	no	IV	7 - 14 days
52	4	M	pneumonia	Moderate	51	9.5	94	12.6	> 94%	no	IV	7 - 14 days
53	4 1/2	M	pneumonia	Moderate	54	13.5	103	13.6	> 94%	no	IV	7 - 14 days
54	10M	F	pneumonia	Moderate	72	7	69	13.7	> 94%	no	IV	7 - 14 days
55	11M	F	Consolidation	Severe	54	7	70	12.4	> 94%	no	IV	7 - 14 days
56	11M	F	Bronchiolitis	Severe	84	7	68.5	14	<94%	yes	nil	7 - 14 days
57	10M	F	Bronchiolitis	Moderate	68	7.5	69	14	> 94%	no	IV	7 - 14 days
58	10M	F	Others	Moderate	56	6.5	67	13.2	> 94%	no	IV	7 - 14 days
59	9M	F	pneumonia	Severe	54	6	67	13.1	> 94%	no	IV	7 - 14 days
60	9M	F	pneumonia	Moderate	52	6	66	13.2	> 94%	no	IV	7 - 14 days
61	8M	F	pneumonia	Moderate	69	6	66	13	> 94%	no	IV	7 - 14 days
62	8M	F	pneumonia	Mild	53	7.5	66	13.8	> 94%	no	ORAL	<7 days
63	7M	F	pneumonia	Moderate	72	5.4	65	12.9	> 94%	no	IV	7 - 14 days
64	7M	F	Others	Mild	56	6.5	65	13.7	> 94%	no	ORAL	<7 days
65	6M	F	Others	Mild	57	6	64	13.9	> 94%	no	ORAL	<7 days
66	2	F	pneumonia	Moderate	78	7.5	80	12.6	<94%	yes	IV	7 - 14 days
67	2 1/2	F	pneumonia	Mild	57	9.5	86	13.6	> 94%	no	ORAL	<7 days
68	2 3/4	F	Others	Mild	56	11	87	14	> 94%	no	ORAL	<7 days
69	2 1/4	F	pneumonia	Moderate	54	7.5	86	12.7	> 94%	no	IV	7 - 14 days
70	2 1/2	F	Consolidation	Severe	53	7	85	12.5	> 94%	yes	IV	>14days
71	2 3/4	F	pneumonia	Moderate	52	8	87	12.6	> 94%	no	IV	7 - 14 days
72	2 3/4	F	Others	Mild	54	10.5	88	13.5	> 94%	no	ORAL	<7 days
73	2	F	Consolidation	Severe	39	7	80	12.5	> 94%	no	IV	7 - 14 days
74	1 3/4	F	Consolidation	Severe	56	8	79	12.4	> 94%	no	IV	7 - 14 days

75	1 1/2	F	Others	Moderate	54	6.5	77	12.2	> 94%	no	IV	7 - 14 days
76	1 1/2	F	Bronchiolitis	Moderate	74	8.5	78	13.6	> 94%	no	nil	<7 days
77	1 1/4	F	Bronchiolitis	Severe	58	8.5	75	13.7	> 94%	yes	nil	7 - 14 days
78	1 1/4	F	Consolidation	Severe	52	7.5	74	13	> 94%	yes	IV	7 - 14 days
79	2 1/2	F	pneumonia	Moderate	54	8	84	12.5	> 94%	no	IV	7 - 14 days
80	2 3/4	F	pneumonia	Mild	77	11	88	14	> 94%	no	ORAL	<7 days
81	2 3/4	F	pneumonia	Moderate	52	8	86	12.6	> 94%	no	IV	7 - 14 days
82	2 1/2	F	pneumonia	Moderate	53	8	84	13	> 94%	no	IV	7 - 14 days
83	2 1/4	F	pneumonia	Moderate	50	9	82	13	> 94%	no	IV	7 - 14 days
84	1 3/4	F	Consolidation	Severe	52	8	79	12.5	<94%	Yes	IV	7 - 14 days
85	2	F	pneumonia	Moderate	68	7	80	12.6	> 94%	no	IV	7 - 14 days
86	1 1/4	F	pneumonia	Moderate	49	10.5	74	13	> 94%	no	IV	7 - 14 days
87	1 1/2	F	pneumonia	Moderate	48	6.5	77	12.5	> 94%	no	IV	7 - 14 days
88	1 1/2	F	pneumonia	Severe	51	7.5	77	13	> 94%	no	IV	7 - 14 days
89	1	F	Bronchiolitis	Moderate	78	8	72	13.9	> 94%	no	nil	<7 days
90	3	F	pneumonia	Moderate	54	10.5	90	13.1	> 94%	no	IV	7 - 14 days
91	3	F	pneumonia	Mild	58	11.5	90	13.6	> 94%	no	ORAL	<7 days
92	3 1/4	F	pneumonia	Severe	57	9	90	13.6	> 94%	no	IV	7 - 14 days
93	3 1/4	F	pneumonia	Moderate	58	10	91	13.7	> 94%	no	IV	7 - 14 days
94	3 1/2	F	pneumonia	Mild	59	11	92	13	> 94%	no	ORAL	<7 days
95	4	F	pneumonia	Moderate	56	10.5	95	12.3	> 94%	no	IV	7 - 14 days
96	4	F	pneumonia	Moderate	54	12	95.5	13.1	> 94%	no	IV	7 - 14 days
97	4 1/2	F	pneumonia	Moderate	55	12.5	98	13.2	> 94%	no	IV	7 - 14 days
98	4 3/4	F	Others	Mild	78	11	99	12.4	> 94%	no	ORAL	<7 days
99	5	F	pneumonia	Mild	89	11	102	13.2	> 94%	no	ORAL	<7 days

100	5	F	pneumonia	Mild	51	12	101	12.6	> 94%	no	ORAL	<7 days
					CONTROLS							
SNO	age	sex			Sr. Zinc	ht(cm)	MAC(cm)					
1	7M	M			112	68.5	14.1					
2	7M	M			89	68.5	14.2					
3	6M	M			94	66	14.3					
4	8M	M			96	68	13.6					
5	8M	M			54	68.5	13.4					
6	9M	M			94	68.5	12.5					
7	11M	M			92	70.5	13.6					
8	9M	M			88	69.5	13.7					
9	10M	M			52	70	13					
10	10M	M			94	69.5	12.6					
11	11M	M			51	71.5	12.6					
12	11M	M			72	69.5	12.5					
13	9M	M			98	68.5	12.6					
14	1 3/4	M			68	82.5	13.6					

15	2 3/4	M			78	90	13.1					
16	2 1/2	M			72	89.5	13.1					
17	2 1/4	M			71	84	13.2					
18	1 1/4	M			74	76	13.1					
19	1 1/4	M			78	76.5	13					
20	2	M			88	87.5	12.6					
21	1 1/2	M			88	81.5	12.5					
22	2 1/2	M			98	88	12.6					
23	2 1/2	M			56	90	13.6					
24	2 3/4	M			108	91	13.1					
25	1 1/2	M			49	80	13.2					
26	2 1/2	M			109	88.5	12.2					
27	2 3/4	M			48	93	14					
28	2 1/4	M			74	84.5	12.7					
29	2	M			78	86	13.6					
30	1 1/4	M			72	77.5	13.4					
31	1 1/2	M			54	80	14					
32	2	M			68	85.5	13.4					
33	1 3/4	M			94	80	13.3					
34	2 3/4	M			90	93	13.7					
35	2	M			88	84	12.5					
36	1.5	M			92	79.5	12.3					
37	2.5	M			52	88	12.6					
38	2	M			94	89	13					
39	1	M			92	72.5	13.1					

40	3	M			54	88	13.3					
41	3	M			108	87.5	12.8					
42	3 1/2	M			94	90	13.1					
43	4	M			58	98.5	13.6					
44	4	M			74	98	13.2					
45	4 1/2	M			68	100	13.7					
46	4 1/2	M			48	99	12.5					
47	3	M			68	88.5	13.3					
48	3	M			48	88	13.3					
49	3 1/2	M			78	89.5	13.4					
50	3 3/4	M			56	90	12.6					
51	4	M			76	94	13.1					
52	4	M			72	94.5	12.6					
53	4 1/2	M			102	103	13.6					
54	10M	F			112	68.5	13.8					
55	11M	F			51	70.5	12.3					
56	11M	F			104	68.5	14					
57	10M	F			110	69	14					
58	10M	F			54	67.5	13.4					
59	9M	F			112	67	13.1					
60	9M	F			98	66.5	13.2					
61	8M	F			88	66	13					
62	8M	F			108	66	13.8					
63	7M	F			71	65.5	12.9					
64	7M	F			52	65	13.7					

65	6M	F			89	64	13.9					
66	2	F			72	80.5	12.6					
67	2 1/2	F			56	86	13.6					
68	2 3/4	F			84	87	14					
69	2 1/4	F			71	86.5	12.7					
70	2 1/2	F			68	85	12.5					
71	2 3/4	F			71	87	12.6					
72	2 3/4	F			78	88.5	13.5					
73	2	F			72	80.5	12.5					
74	1 3/4	F			78	79	12.4					
75	1 1/2	F			88	77.5	12.2					
76	1 1/2	F			102	78	13.6					
77	1 1/4	F			98	75.5	13.7					
78	1 1/4	F			94	74.5	13					
79	2 1/2	F			88	84	12.5					
80	2 3/4	F			112	88	14					
81	2 3/4	F			58	86	12.6					
82	2 1/2	F			88	83.5	13					
83	2 1/4	F			94	82	13					
84	1 3/4	F			74	79.5	12.5					
85	2	F			78	80	12.6					
86	1 1/4	F			54	74	13					
87	1 1/2	F			68	77	12.5					
88	1 1/2	F			78	77	13					
89	1	F			102	72.5	13.9					

90	3	F			112	90	13					
91	3	F			108	90.5	13.6					
92	3 1/4	F			78	90	13.7					
93	3 1/4	F			88	91	13.7					
94	3 1/2	F			89	92	13.1					
95	4	F			73	95.5	12.3					
96	4	F			90	95.5	13.1					
97	4 1/2	F			93	98	13.4					
98	4 3/4	F			71	99.5	12.4					
99	5	F			74	101	13.3					
100	5	F			68	102	12.6					

சய ஒப்புதல் படிவம்

ஆய்வு செய்யப்படும் தலைப்பு

மயக்க மருந்தியல் துறை
கீழ்பாக்கம் மருத்துவக் கல்லூரி

பங்கு பெறுபவரின் பெயர் :

பங்கு பெறுபவரின் வயது :

பங்கு பெறுபவரின் எண் :

பங்கு பெறுபவர் இதனை (✓) குறிக்கவும்.

மேலே குறிப்புட்டுள்ள மருத்துவ ஆய்வின் விவரங்கள் எனக்கு விளக்கப்பட்டது. என்னுடைய சந்தேகங்களை கேட்கவும், அதற்கான தகுந்த விளக்கங்களை பெறவும் வாய்ப்பளிக்கப்பட்டுள்ளது என அறிந்து கொண்டேன். ☐

நான் இவ்வாய்வில் தன்னிச்சையாக தான் பங்கேற்கிறேன். எந்த காரணத்தினாலோ எந்த சட்டசிக்கலுக்கும் உட்படாமல் நான் இவ்வாய்வில் இருந்து விலகி கொள்ளலாம் என்றும் அறிந்தும் கொண்டேன். ☐

இந்த ஆய்வு சம்பந்தமாகவோ, இதை சார்ந்து மேலும் ஆய்வு மேற்கொள்ளும் போதும் இந்த ஆய்வில் பங்கு பெறும் மருத்துவர் என்னுடைய மருத்துவ அறிக்கைகளை பார்ப்பதற்கு என் அனுமதி தேவையில்லை என அறிந்து கொள்கிறேன். ☐

இந்த ஆய்வின் மூலம் கிடைக்கும் தகவலையோ, முடிவையோ பயன்படுத்திக் கொள்ள மறுக்கமாட்டேன். ☐

இந்த ஆய்வில் பங்கு கொள்ள ஒப்புக் கொள்கிறேன். இந்த ஆய்வை மேற்கொள்ளும் மருத்துவ அணிக்கு உண்மையுடன் இருப்பேன் என்றும் உறுதியளிக்கிறேன். ☐

இந்த ஆய்வில் ஒருமுறை 5 மி இரத்தம் பரிசோதனைக்காக எடுத்துக் கொள்ளப்படும் என்பதை அறிவேன். ☐

பங்கேற்பவரின் கையொப்பம் _____ இடம் _____ தேதி
இடம் _____ தேதி _____

பங்கேற்பவரின் பெயர் மற்றும் விலாசம்
சாட்சியாளரின் கையொப்பம்

இடம் _____ தேதி _____
சாட்சியாளரின் பெயர் மற்றும் விலாசம்

ஆய்வாளரின் கையொப்பம்
இடம் _____ தேதி _____

ஆய்வாளரின் பெயர் _____